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No. 1 | Winter 1962 | Vol. XLVIII

Journal
of the
Royal Naval Medical Service

PUBLISHED QUARTERLY

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EDITED BY
THE STAFF OF THE ROYAL NAVAL MEDICAL SCHOOL
ALVERSTOKE, HAMPSHIRE

PRESENTATION TO
SURGEON CAPTAIN J. L. S. COULTER
D.S.C., F.R.C.S.(Eng.), L.R.C.P., R.N. (Retired), BARRISTER-AT-LAW

SURGEON Captain Coulter retired from the Navy on the 30th September to take up an appointment as Medical Director of the British Organization of Armour Pharmaceutical Company Limited, at Eastbourne. All his friends in the Service wish him and his wife every success in the future.

On his retirement from the Royal Naval Medical School and the Royal Navy, the staff of the Royal Naval Medical School and Dr. H. J. Taylor, the Superintendent of the Royal Naval Physiological Laboratory with members of his staff assembled on Friday 29th September, to say goodbye to Captain Coulter and to make a presentation. The presentation was made by his successor Surgeon Captain S. Miles who speaking on behalf of his colleagues gave the following short address.

Surgeon Captain Coulter took charge of the School under tragic circumstances just over three years ago. He came at a time when his administrative ability and skill were badly needed. I know that he went through a period of heartbreaking conferences in which the future of the School was at stake. We must never forget the debt we owe to him. But for his efforts the School may well have been absorbed into a corner of Haslar or some other organization. Today however due to his perseverence it is well established and well respected.

In spite of these difficulties and personal disappointments Surgeon Captain Coulter has throughout his tenure of office maintained a consistent charm and cheerfulness from which we have all benefited. We shall miss him greatly.

Speaking personally I have enjoyed every moment I have served with him. I have learnt a great deal from him and have the greatest respect for his sterling qualities. It is quite remarkable how industry and ability are rewarded in the most unexpected ways. Fate has a happy knack of resolving the patterns of individual life and in the case of Surgeon Captain Coulter, though he is leaving, I know with regret, a Service to which he has devoted the best years of his life, he is going to a post of great responsibility and dignity for which he is admirably suited. The Navy can feel very happy that an organization of international repute has chosen Captain Coulter to be its Senior Medical Administrator. Actually they could not have done better.

"I would like to tell both Captain and Mrs. Coulter that in their new venture they take with them our very best wishes and we hope from time to time they will let us know how they are getting on. We shall certainly not forget them. It therefore gives me real pleasure on behalf of all the personnel of the Medical School, Doctor Taylor and our friends at R.N.P.L. to present Captain Coulter with this briefcase, which I hope he will find useful, and also to ask Mrs. B. Lush from the General Office, to present Mrs. Coulter with a small token of our affection."

In reply, Surgeon Captain Coulter expressed his appreciation of the gift and stated that, though he was leaving the Service with mixed feelings, he had particularly enjoyed his final appointment as Medical Officer in Charge of the School. He gave a brief account of some of the ups and downs of his Service career in his usual amusing and delightful manner. His speech was a particularly intimate one in which he mentioned by name all the personnel of the Medical School, expressing appreciation for the help each one had given him during his term of office. This very personal action will be long remembered by those present who are unlikely to forget the three years during which they served Captain Coulter. There was unanimous and sincere regret at his rather unexpected departure from the School and the Service, but satisfaction that he was going to such a promising and worthwhile appointment.

For the past three years Surgeon Captain Coulter had the thankless task of editing the JOURNAL OF THE ROYAL NAVAL MEDICAL SERVICE during which period its future was very much in the balance. Due mainly to his efforts it still remains solvent and popular. It is quite remarkable how it has been possible to maintain the JOURNAL for so many years without increasing its rate of subscription. Its future depends almost entirely upon the goodwill of Medical and Dental Officers, both serving and in the reserve, without whose support it cannot prosper.

Articles

A HUNDRED YEARS OF MIGRAINE

By Surgeon Lieutenant-Commander W B WRIGHT, R N

IT is just about a hundred years since the entity of migraine was identified by it a name for descriptive purposes We are accustomed nowadays to regard this malady as a symptom of the hurly burly of modern civilization with all its struggles and strains

It may come as a surprise therefore to learn that the clinical picture of migraine down to the last intimate detail was freely available to doctors and students in the Sixties of the Nineteenth Century

Headache is one of the commonest symptoms which brings naval ratings to the doctor, and a large proportion of these are labelled "migrainous The frustration which attends our efforts to get the patient to admit his headaches are better is very familiar to us all Admittedly this is partly due to the fact that ratings have nothing to gain materially by a rapid recovery and nothing to lose from a lengthy illness They respond accordingly Apart from this however the genuine migraine sufferer—and how obviously genuine he is!—undoubtedly presents a difficult therapeutic problem

How far then have we advanced over a hundred years in the treatment of this condition?

The following description would appear to define our terms adequately enough

The phenomenon of migraine or sick headache affects those of a sedentary employment, out of health and having a tendency to costiveness but may sometimes attack those of vigorous health usually after an indiscretion of diet It almost always first attacks individuals at some time during the period of bodily development The headache usually comes on early in the morning, and is preceded by an indistinctness of vision sometimes affecting half the field of vision of one or both eyes There is then increasing headache affecting one or both temples and the eyeballs may be tender There is associated depression and chilliness Bright light and loud noises become intolerable When the pain in the head supervenes, the indistinctness of vision usually disappears The malady may last only an hour or up to 48 hours If the pain lasts for any considerable time, nausea and vomiting are induced There after the affection begins to subside and the patient usually falls asleep

The above is a precis of the salient points of an 1868 textbook description of the symptoms (Reynolds) and would satisfy most of us Even before this date the clinical picture was well known but it was so intimately linked with gastro intestinal upset in the minds of physicians that one found it only among the passages devoted to diseases of that system (e g Elliotson 1839)

In the words of Thomas (1825) there was felt to be a "great sympathy between head and stomach and accordingly it was considered "advisable to give a gentle

emetic and if any costiveness prevailed this should be removed by some proper laxative. Where the disease proceeded "to over fullness of the vessels," a "proper quantity" of blood could be drawn off by opening the jugular vein on the side most affected or by applying leeches to the temples.

By the "Sixties" the last intimate details of the clinical picture including family history, predisposition, menstrual association, visual scotomata and paræsthesiæ had been painted. The alimentary link was still stressed and it was thought that "the best remedies in these cases appeared to be mercurials in purgative doses." Physicians were unhappy about ætiology though. They observed that dietary indiscretion did not always precede the symptoms, nor did vomiting always cure them.

By 1876 (Bristowe) real doubt was being thrown on gastro intestinal ætiology. It was felt that the syndrome resembled epilepsy more closely though it was obviously a different thing. Such factors as uterine disturbance, sustained concentration, sleep disorder and meteorological conditions were envisaged as significant. The actual vascular mechanism of the headache—vasospasm with ischæmic paræsthesia followed by vasodilatation with pain—was conjectured about this time.

These theories loosed the floodgates of treatment. The patient was exhorted to "live wholesomely" to "inhale the fresh healthy air of the country" and to "avoid too much worry." (Is there not a familiar ring to these hearty platitudes?)

Medication was directed towards both prevention and treatment. Prophylactics used with "more or less success" included iron, zinc, arsenic, iodides, bromides, potassium chloride, quinine, strychnine, belladonna, hyoscyamus and valerian. For the attacks it was recognized that nothing did the patient more good than to lie down in a dark room with his eyes closed. Many measures were exhibited however, including pressure on the carotid artery, local application of evaporating lotions and a cup of strong tea or coffee. Others included guarana, brandy, ammonia, alkalies or applications of belladonna or aconite. (The Aconitia ointment was regarded as "especially good.")

In the "Eighties" the gastro-intestinal tract was out of fashion, associated vomiting being regarded as "merely indicating the lowest point in nervous depression" (Roberts, 1888). A vascular mechanism was seriously entertained but, on the whole, the syndrome was believed to be related to Trigeminus Neuralgia, or "Nerve storms traversing the sensory tract from the optic thalami to the ganglia of the vagus." Among eighteen different remedies mentioned only one was a purgative and the top two places of the list were occupied respectively by brandy and soda, and champagne!

It would seem that little notice was taken of Eulenburg's (1883) comment on the efficacy of ergot in acute attacks, for it was not until 1902 that ergot was mentioned, even in passing, in a standard work (*Medical Annual* 1902) as follows: "*For the attacks*, give Ext. Ergotæ Liq. et Inf. Cinchonæ of each half an ounce in water, or give Lactophenine gr. x with Caffeine Citrate every two hours, or Antipyrin gr. xv with Aromatic Spirits of Ammonia." This advice was continued unmodified to 1908 and a *British Medical Journal* appraisal of migraine of that year (Dobson, 1908) made no mention at all of ergot.

Writers such as Thompson (1894) had agreed with Eulenburg's successful results,

but there was always an abundance of dubious remedies continually appearing among which dross the gold glittered but feebly.

People were prepared to try anything. There was, for example, the article published in the *B.M.J.* (Whitehead, 1901) which described the following remedial operation:

"The skin at the back of the neck is grasped between the finger and thumb of the left hand and behind the fingers a long bladed scalpel is forced so as to transfix the skin. Before the knife is removed a long probe provided with a suitable eye is passed through the wound using the knife as a guide. The scalpel is then withdrawn. A piece of ordinary household tape half an inch wide is then attached by a ligature to the eye of the probe and pulled through the wound." The four inch free ends of tape were then tied in a loose bow to prevent it being accidently withdrawn and the patient was instructed "to move the tape from side to side each day. The tape was to be worn uninterruptedly for three months!" The technique won approval and applause, and others (Fentem, 1902), (Watson, 1902) wrote quoting examples of the striking benefit to be derived sufficient "to exclude any moral effect which might be involved." (Cornish, 1902).

The isolation of pure ergotamine tartrate (Stoll, 1918) brought the focus of attention on to the substance. Maier (1926) described its efficacy on a number of diseases with migraine at the head of the list. Tzanck (1928) followed with a description of its specificity for that condition.

The decisive symptomatic benefit to be derived from an early injection of 0.5 mgm. of ergotamine was related by Ignelzi in 1932. Treatment by injection has never been very popular in the medical practice of this country, especially if the patient has to be trained to do it himself—and if the symptoms were to be dispelled effectively, the injection had to be given in the premonitory phase while the doctor was out of reach. Doctors would gladly have used anything else of any worth. Countless remedies continued to turn up therefore, including massive doses of vitamins, hormones, nitrites, oxygen inhalations and the local anæsthetics (Graham, 1956). However, it remained quite clear that the best treatment was ergotamine. Various efforts were made to improve its effect when taken by mouth, such as combining it with caffeine, phenothiazine derivatives and other substances. For all that, as Greene stated in his *British Medical Journal* review in 1959, when compared with injections or suppositories of ergotamine, tablets were "the least effective form of therapy—occasionally satisfactory in the occasional patient". Suppositories seemed to work quite well, but they were no less embarrassing and barely more convenient than injections.

In the autumn of 1960, Speed and Ryan simultaneously published excellent reports on a new method of administering ergotamine. This was in the form of a tiny pocket ærosol inhaler ('Medihaler Ergotamine') which automatically dispensed a dose of 0.36 mgm. of ergotamine with each inhalation. Among migraine sufferers whose numbers taken together totalled 125 cases, these publications showed striking results quite comparable with those expected of injection therapy. The ergotamine was absorbed immediately from the lungs without any local ill effect, except a some bitter taste. A device of this kind eliminates the difficulties of injections and rectal insertions and would of course be far more acceptable to the patient. It would

seem quite possible that this might become the standard method of aborting the acute attack for ergotamine is the only single drug which has withstood the passage of time Indeed ergotamine treatment would appear to be the only thing we have really learned about migraine in a century of effort

For the prevention of attacks Dihydroergotamine drops (Drury 1958), Prochlorperazine (Hagenbach 1960) Reserpine (Graham 1960) and of course, psychotherapy (Fry 1956) (Hunter and Ross 1960) are some of the measures in vogue at present, and the textbook advice to young doctors of today is suspiciously similar to that delivered by equivalent tomes of a hundred years ago

If we do not get to the root of the migraine phenomenon in the next hundred years, I feel sure that hearty generalization on hygiene will still form part of any dissertation on the treatment of the malady available to doctors of the 21st Century

ACKNOWLEDGMENT

I wish to thank Surgeon Rear Admiral D Steele Perkins *C V O* F R C S (Eng) F R A C S, Q H S for permission to publish this article

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THE CENTENARY OF J. S. HALDANE

By Surgeon Captain S. MILES, R.N.

OUTSTANDING contributions to Naval Medicine are from time to time made by members of the profession who are not themselves Naval Medical Officers. In the forefront of these must be placed the late Professor John Scott Haldane, C.H., M.D., F.R.S., who died at the age of 76 in 1936. He is best known for his pioneering work on the physiology of respiration. Though he was born in 1860 it was in the summer of 1961 that the Physiological Society in conjunction with the Department of Physiology of Oxford University organized a symposium to celebrate the centenary of his birth. This symposium, which attracted the world's top physiologists, took the form of a week of intense lectures and discussions with the majority of the delegates residing in University College. This enabled them not only to have the benefit of listening to first class papers, but to continue discussions round the dinner table and often into the early hours of the morning.

Haldane is probably best remembered by doctors as the designer of the gas analysis apparatus which bears his name and which all medical students meet at an early stage in their careers.

His contributions to Naval Medicine are much more profound. To him must go the credit for ridding the diving world of the dreaded and debilitating condition of decompression sickness. The diving manual of today still contains schedules for decompression based on Haldane's original hypothesis. These may have been modified to some extent, but basically it is upon the work of Haldane they depend. His interests in deep sea diving, however, extended far beyond the formulation of the diving tables. In a monograph on respiration written in 1922 there is a chapter on the effects of high atmospheric pressures which includes a description of the diving dress and the development of the Diving Bell and the Caisson.

His investigations were carried out on behalf of the Admiralty Committee on Deep Diving and included not only his work on decompression sickness, but a study of the effects of excessive carbon dioxide in the divers' helmets and the question of carbon dioxide poisoning. Some years later, in 1935, in conjunction with J. G. Priestley, he wrote a textbook on *Respiration* which to this day remains a valuable source of information and has indeed become a classic in this particular subject. His interest was not confined to respiration; the closely associated circulatory system had not escaped his enthusiastic investigation and, working with his friend and colleague Professor C. G. Douglas, who is alive today and who paid tribute to Haldane at the symposium, he made many valuable contributions on the regulation of the general circulation in man. He was one of the first to emphasize the importance of the influence of carbonic acid, oxygen and hydrogen ion concentration on the responses

of the respiratory centre. And again, with Douglas, he studied the capacity of the air passages in varying physiological conditions. The physiological effects of raised temperature and humidity also stimulated his interest, and a brief historical consideration of these factors is to be found in the report published by Haldane in 1925. Even heat under great pressure was included (Haldane, 1908). It is quite remarkable how many of the findings of Haldane have withstood the challenge of years of research. As for example his work with Dautrebande in 1921 which stated that breathing oxygen caused an increase in respiration, a slowing of the pulse, a reduction of the rate of blood flow and a drop in alveolar carbon dioxide pressure. It would be possible to go on and on listing the academic achievements of J. S. Haldane in the field of general physiology and reference to the professional journals of his day show his output of informative articles to be second to none in quality and quantity. It is, therefore, beyond any shadow of doubt that basic medicine owes much to this pioneer and the indebtedness of the Navy cannot be evaluated.

Haldane himself was an impressive figure and inspired both his co-workers and many people with whom he worked outside the medical field. Two of these are worthy of special mention as they are both alive today. One is Captain G. C. C. Damant, R.N. (Rtd.) who, as a young Naval Lieutenant and diver, co-operated with Haldane and was a guinea pig in much of his earlier work. He was indeed one of the first men to experience an oxygen convulsion. The second colleague of J. S. Haldane who is also alive today is Sir Robert Davis whose life has been devoted to the firm of Siebe Gorman, pioneers in this country in the development of underwater equipment. Sir Robert, who is 93, spoke at dinner during the symposium paying tribute to his friend, impressing all by his intelligence and vigour.

Haldane's work for the Services, however, was not exclusively dedicated to the Navy, for he served as a member of the Army Committee called together to study the physiological needs of the soldier as regards food, clothing and training. This resulted in considerable modification in the scale of rations for active service and an improvement in the health of troops during the First World War. He played a significant part in the provision of the early anti-gas respirator to protect the men against Chlorine which the Germans were using in the First World War.

During his career he achieved many academic distinctions and became a fellow of the Royal Society in 1897 and a Companion of Honour in 1928 in recognition of his outstanding contributions to the fight against industrial disease.

So much for the scientific achievements of this great man. As an individual he was equally impressive and there can be no better way to describe this side of his character than quote the final paragraph of his obituary notice which appeared in the *Lancet* on 21st March, 1936.

"Haldane was also a great personality—one of those men who go about with an aura—and those who were lucky enough to be among his pupils at Oxford will know what a pity it is that he had not done any undergraduate teaching for more than 20 years. And yet his freedom from the cares of routine gave him time and opportunity for his wonderful output and there are many graduate students who are

profoundly in his debt Kindly courteous considerate he did not suffer fools gladly and he was apt to be a little impatient with criticism There was indeed seldom much room for it

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PART V. A CONCISE TREATISE ON MARINE SCIENCE

Chapter III—Biological Aspects

By Surgeon Commander J. GLASS, R.N.

Part Three

The surface of the ocean is not unmarked or trackless, although it may seem so. It is divided into definite zones and the zonal pattern affects the distribution of life it supports. Fishes, squids, whales, plankton and birds are all linked by strong ties to certain types of water—warm or cold, clear or turbid, rich in phosphates or silicates and of higher or lower salinity.

The fish of the higher food scale are less directly bound by these links—only by the waters where the food for them is plentiful, since it follows that the water would be under ideal conditions for such food to be there.

At every level of the sea there are vast three-dimensional territories, all differing in their characteristics from one another, but each in itself a stable environment which supports its typical life. These dimensions, so called, are the temperature, salinity and pressure.

Change of temperature is probably the most important single condition that controls the *wide* distribution of marine animals.

Life below the surface is a savage unrelenting struggle for existence. With no lush vegetation on which to feed, the animals are obliged to eat each other. In this darting, slashing warfare of the underwater jungle, the race is to the swift and the battle to the strong. Until oceanographers began to explore the ocean's depths it was believed that animal life was confined to the light dispersed surface layers. The little we know about creatures living in deep waters has come from oceanographic expeditions that have sailed since the end of the Second World War. When the Danish research ship, the *Galathea*, returned to Copenhagen in 1952, the scientists aboard her brought back over 200 species of deep sea fish from the waters of the Philippine Trench. Many had not been seen by man before and had lived at depths of more than three miles. Although these fish had been attuned to life at a pressure hundreds of times greater than atmospheric pressure, these animals did not expand and burst as they were brought to the surface. They died through heat stroke, caused by the rise in temperature from near freezing point to 80°F on the surface.

The ability of deep sea creatures to withstand great pressure is not so remarkable as it sounds. Water is virtually incompressible so that the liquid filled tissues of the animal are not destroyed by the tremendous pressures outside them. It is only when there is gas in the animal body that expansion takes place as the pressure falls. Fishes living in very deep water have replaced the air of their swim bladders with light, incompressible fat (see page 15).

The biological processes in the sea are in continuous operation and vary in

intensity, in areas by seasons. The materials for production and survival of phytoplankton include the nitrates, phosphates and CO_2 dissolved in water, noted in the previous section as the raw material giving body to active protoplasm. Other constituents of the organic content are carbon, nitrogen and phosphorus.

Carbon is utilized as carbohydrate and is the result of CO_2 dissolved in water changed by photosynthesis under action of sunlight into the required carbohydrate

$$6CO_2 + 6H_2O = C_6H_{12}O_6 + 6O_2$$

The density of phytoplankton has been found in favourable circumstances to be related to changes in the phosphate supply of the water. The carbon, nitrogen and phosphorus bear a fairly constant ratio to each other, in the analysis of plankton. It is respectively 15 : 7 : 2 : 1 by weight. The N : P ratio is close to the relative amounts in sea water, which means that plankton make the optimum use of these resources in the sea.

Sea bed plants are usually abundant in areas well supplied with nutrient salts for replenishment, such as river estuaries. Other factors are latitude, clarity of water and chemical composition, and the structure and stability of the surface layer of the sea floor. Muddiness, as we know, reduces the penetration of the sun's rays. However the average maximum depth of growth is about 100 metres in the Tropics and rarely deeper than 20 metres in latitudes above 60° N.

Growing phytoplankton is only found in the upper sunlit layer of the sea, i.e. to a depth of about 80–100 metres, though zooplankton exists at considerable depths below this, feeding on other dead plankton. The bulk of zooplankton lives near the sunlight-penetrated Euphotic zone where the main food supply for them prevails.

Plankton depend on ocean currents for movements and the smaller ones on a flotation mechanism to keep them from sinking. The specific gravity of sea water is 1·02–1·03 while that of living matter is 1·02–1·10. Some animals and plants reduce their specific gravity by reducing the relative weight of their skeletons. They do this by taking on extra body water, or by storing oil droplets or gases.

The activities of the microscopic vegetables of the sea, the most important, the diatoms, makes the mineral wealth of the water available to the animals of the sea. Those who feed on the diatoms directly and other groups of minute unicellular algae are the marine protozoa, crustaceans, some carnivores and shrimp-like euphausids. This community of marine plants and the creatures they sustain is *Plankton*, the wanderers of the sea surface layers.

The next links are the schools of fish feeding on the plankton, and then on to the fish feeding on these fish, to the pelagic squids preying on these larger fish, and so on to the great mammal whales who, according to their species, feed on plankton, shrimps, fish or giant squids.

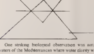
Food chains are directly related to the number of sea animals. Carnivores can never become more numerous than the herbivores they eat, without grossly upsetting the balance of existence. One calculation notes that 20 per cent of plankton plant life supports 10 per cent of planktonic animals, 40 per cent of animal plankton supports 10 per cent of small predators, 20 per cent of small predators supports 10 per cent of medium size predators, and at the highest energy level or the furthest point of the food chain, 40 per cent of medium size predators support 10 per cent

of the largest predators the killer whale or white shark This explains the relatively small number of the large voracious predators

Due to the constant sinking of a proportion of dead matter and excreta below the surface layers before it can be fully transformed into inorganic nutrients, the concentration of these substances increases with depth At 1 000 meters the phosphate concentration could be as much as 10 times that at depth of 100 metres The concentration below that depth increases still further but relatively slowly

The rate of sinking of dead creatures is slow A fairly large copepod has been estimated to fall at a rate of approximately 1 cm per second or two feet a minute At this rate it would take a few days to reach a mile deep This gives ample time for the dissolution of the smaller bodies before they reach the deep sea bottom if they are not in the meantime eaten by sea creatures of the intermediate depths This is borne out by the absence of great accumulations of solid organic wastes in the great depths of the sea, excluding the skeletal deposits in shallower waters There is too on the other hand a considerable amount of organic matter in dilute soluble form Coker (1947) quotes Krogh who noted that where upwelling of these nutrient waters occur the abundance of planktonic life imparts a distinct green tint to these waters As the currents spread these areas of fertility farther and farther the waters become poorer in these salts and the large areas of ocean which are purely blue can be regarded as virtual deserts in the vast seas unable to support anything but meagre colonies of sea dwellers

The food chain of the deep sea follows an unusual pattern Several observers have noted that life decreases from the upper zones to the dysphotic zone and then increases downward Deep sea plankton forms the " deep scattering layer which can be detected by echo sounding gear Observations from the Bathyscaphe indicated increased abundance of life in the depths and that the deep scattering layer was the upper zone of this abundance The link is bacteria which causes decay and nitrification of the constantly falling dead animals whereas in the upper layers photosynthesis is the basis of life Bacteria then can be regarded as the plankton of the depths, and since they are most abundant in great depths so are the animals that feed on bacteria Ray and Ciampi (1958) described this feature as the hour-glass of abundance of sea life



Photosynthesis—plant plankton

1 500 feet

Animals of the Deep Scattering Layer

Nitrifying Bacteria

One striking biological observation was noted by Dietz (1958) in the deep waters of the Mediterranean where water clarity was good but not perfect Scattering

particles were seen in the floodlights of the Bathyscaphe These particles have been termed "sea snow" In some layers this snowstorm became heavy particularly in dark waters, and was composed of matter too small to identify It was presumed to be organic detritus and nannoplankton, radiolaria diatoms and coccolithophoride The maximum concentration of life and "sea snow" occurred between 1 650 and 2 300 feet the level about the maximum depth of penetration of sunlight Above this depth organisms respond to day and night At the greater depths this diurnal rhythm is no longer felt by the abyssal animals In the oceans with no place to shelter, many shallow water forms seek safety in the darkness by migrating to the nearly black depths during the day and as there is no reason for sea life to descend any deeper than the darkness belt line this factor may account for the concentration of life between the depths noted above

There are some areas where vertical water movements take place This upwelling takes place along the Equator in the Pacific off California Peru and north west and south west Africa In these areas the seas are also particularly rich in fish This upwelling is due to rotation of the earth where westward moving deflects to the right in the northern hemisphere and to the left in the southern

A high productivity of phytoplankton is found in a world-circling belt at 50° to 60° South varying with longitude where deep water after a long coursing southwards in the depths comes to the surface It does this to replace the water which leaves the surface layers about Antarctica The mechanics are such that when water at the sub polar region is cooled by the air it sinks to the bottom of the ocean and begins to course northwards At the same time the very surface layer does not sink despite its cooling due to rain snow and melting ice, its salinity is low and hence its density is low It then moves away from the continent as a sub-polar current on the surface The upwelling water replacing this movement comes a great distance southwards as a deep current During this journey it collects large quantities of nutrient matter as noted above from the layers above it This gigantic conveyor belt of materials reaches the sunlight zone and stimulates life in the form of phytoplankton particularly diatoms This supports a rich plankton which in turn permits the abundant whale population to exist in the circumpolar belt

The land masses in the northern polar region as noted, interfere with similar large scale circulation of the surface and deep waters of the Polar oceans There is however a large turnover of water in the winter season due to cooling and sinking of surface water and replacement by the deep nutrient rich water Despite the fact that tropical waters have a higher temperature and plenty of sunlight these waters tend to be vertically stable because the warm surface water being less dense stays on the surface and there is a poverty relatively of nutrients in it In areas of high evaporation however the increased salinity and density may lead to some sinking taking place The only constant movement occurs in areas of the Trade Winds

Summary of some Influence on Sea Life

(A) *Light*—In the upper portion of the sea, to a depth of about 250 feet, oxygen is produced by photosynthesis In general as depth increases light penetration diminishes and plants produce less and less oxygen At the 100 feet depth level, the compensation level plants use as much oxygen as they produce Oxygen is

dissolved [illegible] the [illegible] layer and the rougher or [illegible] the water the more oxygen is [illegible] and the more it is distributed by currents. Conversely at the depth of [illegible] 1,500 feet little oxygen is present and what there is is being consumed by the life that is about. Deeper than this there is an apparent increase in oxygen content of the sea carried to the depths by the saturated sinking cold waters of the Polar seas. In some deep areas water becomes stagnant and no oxygen enters. In such instances H_2S accumulates from falling dead matter. In the Black Sea practically no deep sea life exists at a depth of 600 to 6,000 feet due to the great volume of H_2S that forms there.

(B) *Temperature* has several purely physical affects on water and on the animals living in certain areas. Cooler waters are denser and of greater viscosity than warm water and in this increased viscosity plankton sink only slowly. This is the explanation, in part, of the large concentration of plankton in the upper layers of the Arctic and Sub-Arctic waters and in the deeper waters of the warmer seas, as well as their relative scarcity in the shallow warm waters. However other factors enter into this complex affair of diversity of sea life and we know that under certain conditions small animal sea life species with greater surface to volume ratio are better fitted for living in the upper warmer waters while larger species with this ratio reduced will be better supported in the cold viscous waters in the depths.

(C) *Protoplasm* as we know is heavier than sea water. *The Specific Gravity* of protoplasm as previously recorded is generally noted as 1.02–1.10 while the specific gravity of sea water varying with temperature pressure and salinity, ranges from 1.02–1.03. Plant life can remain however poised in mid-water depths, and this buoyancy may be due to cell sap which is a lighter salt complex than the sea water constituents in a diatom. Algae as well can exclude heavier divalent ions from cell sap.

(D) *Pressure* changes of the sea depths do not seem to affect plankton. By day a large proportion of plankton live just at the edge of the lower border of light in the sea at a depth of 1,200 feet to 1,500 feet. At night plankton rises to the surface to exist without any apparent discomfort over a change of 30–40 atmospheres of pressure, which occurs twice over a period of 12 hours. Thus pressure really plays a minor role influencing life at great depths. Temperature darkness lack of oxygen and the food supply add up to the major determining environmental factors. Pressure causes formation of colloid gels in cell structure of protoplasm which then takes on more water and this is seen in the gelatinous texture of tissues of deep sea animals.

Some interesting data is noted about the depths of the sea and how many bony fish with swim bladders accommodate gravitational forces (Marshall 1954).

The swim bladder a gas filled sack lies in the upper part of the body cavity below the vertebrae and kidneys. Many of the oceanic-pelagic and benthic species have a *closed swim bladder* while some fishes of the coastal seas like herrings have *open swim bladders* which lead to the sea by way of a pneumatic duct. The tissues of bony fish are heavier than sea water with an average calculated specific gravity at 1.076. It is further estimated that the proportionate volume of a swim bladder necessary to keep a fish afloat in the sea follows the familiar Archimedes Principle whereby a body immersed in water displaces a volume of water equal to the amount of

[illegible] thus if a fish displaces 100 ml [illegible] [illegible] calculated from the equation

$$W = PV$$

(W [illegible] of fish in grammes) (P = specific gravity of fish tissues)

If the fish floats it must have the same weight as the displaced sea water so that

$$W = 100 \times 1.026 \text{ grammes}$$

(Average specific gravity of sea water)

To complete the equation then

$$100 \times 1.026 = 1.076\ V$$

(Specific gravity of fish tissues)

$$\text{and } 95.4 = V$$

If the tissues occupy 95.4 ml then the volume of the swim-bladder is 100 – 95.4 ml or 4.6 ml.

For a fish to float in hydrostatic equilibrium the volume of the swim bladder should be about 5 per cent of the total volume of the fish. Most of the marine fishes without swim-bladders including sharks, remain at mid water levels by unceasing activity. In the case of sharks, the rich oil content in their liver acts no doubt, as a useful buoyancy tank.

With a descent of 10 metres the hydrostatic pressure of the sea increases by one atmosphere and thus at 500 metres deep the water pressure is 50 atmospheres. A practical exercise can be followed if we consider a fish descending from 50 to 500 metres where the pressure increase will be raised from 5 to 50 atmospheres. If a fish has a swim-bladder of 100 cu ml volume, and if it does not produce more gas according to Boyle's Law the bladder will shrink to a volume of about 10 cu ml

$$\frac{5 \text{ atmospheres} \times 100 \text{ cu ml}}{50 \text{ atmospheres}} = 10 \text{ cu ml}$$

When the fish levels off from the dive lasting perhaps two hours the process of restoring buoyancy may not be complete but can be done while it is swimming at the familiar level. In reverse when a fish moves from 500 to 50 metres and if no gas in the swim-bladder is lost it will expand from 100 cu ml to 850 cu ml. Without considering the opposition to expansion offered by the walls of the swim-bladder and the body wall the fish must lose 750 cu ml of gas during the upward swim in the period of ½ to 2 hours. This can be done as the swim bladder has a large surface area for reabsorption compared with the volume of gas it carries considering that the surface to volume ratio of a sphere is $\frac{3}{r}$ where r is the radius.

For pelagic fish living below the upper parts of the deep sea environment the 500 metre level the problem is solved by some fish turning the swim-bladder into a store for buoyant fats or by loss of it altogether.

The components which tend to "sink" a fish are the proteins of the musculature and the skeletal minerals. Some deep sea fish have a density close to that of the sea water they inhabit. They have a protein percentage of some 5 per cent compared with approximately the 17 per cent of protein of a typical coastal fish. The skeleton of deep sea fishes is less dense than that of their surface counterpart. Radiographs have been taken which show a lesser degree of ossification and in consequence the

muscle pull [illegible] comparison with creatures of the surface waters (Denton [illegible])

The cuttle fish h[illegible] which is better than the swim bladder of fishes to sustain changes in pressure The cuttle bone a rigid structure, not impermeable to water is constructed into pillars and chambers with a partial vacuum maintained inside it The pumping action and function of the space is largely osmotic Fluid inside the cuttle bone has a lower osmotic pressure than either blood or sea water On one surface over the end of the chambers is a covering membrane which has a system of vessels draining the surface of the bone into the circulation

With depth changes the exchange of some water between the cuttle bone and the circulation re-establishes the equilibrium between osmotic and hydrostatic pressure without disturbing the buoyancy of the cuttle fish

The cuttle bone is much larger in proportion than the swim bladder, amounting to 9 per cent of the creature s volume It also serves as a skeleton and its structure with lamellæ held apart by numerous pillars is well adapted to sustain compression The osmotic pressure difference between cuttle-bone liquid and blood sufficient to hold water out of the bone is in itself not enough to sustain the hydrostatic pressure at depths of the sea

Denton (1959) described a remarkable buoyancy organ found in the deep sea squid which normally exist in complete buoyancy equilibrium with sea water The buoyancy chamber is the large fluid filled Cœlomic cavity which occupies two-thirds of the volume of the squid The fluid is a watery odourless solution of an osmotic strength equal to that of sea water of low density The lowering of the density to 1 010 is achieved by replacement of most of the cation component of sea water (density of 1 026) by the ammonium ion which exists at the striking concentration of 0 5 molar—about 9 grammes/litre The ammonium ion which is an excretory product of protein metabolism in the animal is apparently stored and the squid uses it to improve buoyancy and hence reduce energy expenditure working against gravity

This method of buoyancy is very largely independent of depth Its great disadvantage is the bulk it occupies a volume noted to be 200 per cent of the remainder of the cranchid squid compared with 5 per cent of the volume of a fish with the swim bladder mechanism

(E) *Importance of the aspect of colour affecting sea life* (*Raj and Clamps 1958*)

Adaptive Colouration as noted by Colt depends on the three factors which are the basis of vision The first the physics of light, is concerned with the intensity and quality of rays that are emitted by an object Secondly the physiology of the eye and nervous system gives a shape or form dimensional picture of the object seen to the brain The third and most important is the interpretation of that picture in the brain which affects the next action As the brain knows what it sees in the light of experience the essential feature to adaptive colouration is subterfuge by one creature on the visual interpretation by another, the observer—either to make it harder for enemies to detect, or to make it more difficult for prey to become aware of its presence This is carried out by *Concealment* and four methods are adopted

(1) *Colour resemblance to usual background* A camouflage of the substrate The red colour of deep water or nocturnal animals as previously noted might also be

adaptive to make them appear black. A large number of deep sea species are transparent, a protective lack of body colour, thus imitating the ocean water transparency.

A few sharks are known to change colour. Generally they are of lighter body colour in open water over a light bottom or near to the water surface, but then change to a darker colour in conditions of a dark bottom or in dark, shadowy places.

(2) *Obliterative Colouration.* Found mainly in open water dwellers. It involves the principle of countershading, where the animal is darker above rather than below. This feature in addition to lighting from above makes the animal look flat and inconspicuous. The Mako shark exercises this adaptation and very often has been described as a shark's ghost passing a diver. Such countershaded fish appear dark when seen from above, and when seen from below appear light against the surface. Many fish are countershaded in addition to other colouration adaptations.

(3) *Disruptive Colouration.* Matching colours alone are not enough to conceal an animal and they use other methods to break form and outline. Stripes or bars are effective in breaking the best clue of all to outline. The eyes of many animals are the most notable feature and they are then frequently concealed by a stripe or pattern disguise.

(4) *Shadow Elimination.* Animals make their presence known by the shadows they cast and any elimination of such shadows would assist concealment. The best means of doing so is found in bottom dwelling flat fish.

Very often all four aspects are combined in an interplay of factors to achieve better means of survival and often too advantage is taken of an entirely different form of adaptation which does not assist concealment and is in fact, the opposite. This is *Aposematic Colouration*. The purpose for this conspicuous colouration might be to serve as a warning or as an aid to food seeking.

It has been observed that such conspicuous looking animals in their own environment also appear to act in a conspicuous manner. Two aspects of this pattern are enlarged upon.

(a) *Warning or Conspicuous Colours* are demonstrated by sea animals for many purposes: the advertisement of the possession of poisonous flesh or spines, or some other distasteful or dangerous feature they have which removes fear of attack. In possessing this they invite easier recognition so that would-be annoyers could stir their memory of former failure and leave them alone when they see them again.

(b) *An Emphasized Local Characteristic.* This feature makes one part of the body outstandingly conspicuous. In this group there are examples of actual menacing physical features as brightly coloured barbs, spines or ocellar spots which are real warning devices. Other species use this method but without a dangerous weapon built into their framework—they use bluff instead, making a show of startling colours to frighten off aggressors.

Other purposes of localized conspicuous characteristics are seen in fish that lure prey to a dangerous part of the animal and then to their death. Some species have a conspicuous mechanism to attract the unwary to a harmless part of its framework and when it has succeeded the inconspicuous claws, tentacles or jaws catch the victim who was unwittingly lured into position. To avoid pursuit, some fish have colouration misrepresenting the posture or position of the animal so that it appears

[illegible] treading water when it is really moving [illegible] [illegible] behind which they retreat and some discard part [illegible] which [illegible] if escape is achieved—an adaptation of [illegible] is like concealment, but in this case the resemblance to some [illegible] objective not subjective with the purpose still protective or ambush

What is seen by the diver or underwater explorer in the sea world appears different to each species and what to man appears bizarre in colour or shape of a sea animal or oddity of behaviour must be linked to a particular method of survival adapted to the sensory and motive ability of that particular sea animal as well as to those who regard it as prey

Denton (1959) quotes an appropriate limerick by E D S Corner a colleague at the Marine Biological Association Plymouth

> The use of these luminous lures
> An adequate diet ensures
> Like people on telly
> It fattens its belly
> By feeding on gullible viewers

Animal Luminescence

A correspondent records in a press article that a member of the Woods Hole Oceanographic Institution Massachusetts noted that flashing lights of deep sea fish and other marine organisms have been recorded photoelectrically through cable down to a depth of 12,000 feet on the sea floor Maximum flashing was noted by the observer at a depth from 3 000 to 3 300 feet This aspect of animal luminescence was recently reviewed by J A C Nicol of the Marine Biological Station Plymouth This confirms the findings of W Beebe in his bathysphere when at this depth in 1935, he stated that "the jet blackness of the water was broken only by sparks and flashes and steady glowing lamps of appreciable diameter varied in colour and of infinite variety as regards size and juxtaposition

The basis of this luminescence the conversion of chemical energy into light energy is linked to the enzyme luciferase in reaction with three substances—*luciferin* which might be converted and reconverted reversibly into an intermediary form *magnesium* and *adenosine triphosphate*—stated to be the source of energy release when muscles contract

There are three distinct forms of luminescence of marine organisms In some the light comes from specific organs with light emitting cells Others secrete a luminous discharge into the water The less common type is the source of light formed by the bacteria living in the animal

The difficulty of research in the subject is illustrated by single species showing more than one type of luminescence

The time interval of luminescence varies widely amongst different animals The flashes may be continuous or short spurts of light lasting little more than 1/10 second In contrast some worms can expel clouds whose luminescence lasts about 20 minutes

Again different species have different flashing frequencies which vary with the upward or downward phase of daily migrations It has been shown that the greatest rate of flashing takes place during the twilight upward migration

It is known that light responses have resulted from electrical stimuli suggesting that stimulation of the nerve arrangement mechanism is responsible. It has also been noted that from these light flashes of a luminescent animal there is no evidence of any recorded electrical potential.

Present investigations involve identification of various species that emit light and for this purpose deep sea cameras incorporating photoelectric recording equipment have been designed to plot the flash rhythms and the animals associated with them. Press Report 10.

Locomotion

Cetacea offer much of biological interest but as they range the wide sea it is rather difficult to carry out adequate field studies. There is a very large commercial aquarium Marineland, in Florida, where it is possible to make such observations. Backhouse (1960) records the feat of a dolphin who regularly jumped to a height of 16 feet to retrieve a fish from the end of a pole. The analysis of this sprint from a hovering start 50 feet away would require a speed of 20–25 miles per hour to achieve the performance.

R. W. L. Gawn, an Admiralty architect, interested in the efficiency of motion of these creatures postulated, after tank tests on scale models and dead cetacea, that the surface of the living animal may have some special adaptation that reduces friction and turbulence. This is considered unlikely by Backhouse (1960). From the study of muscle power output, a propulsive efficiency of 0.75 was assessed for the tail action of a 90 feet-long blue whale, weighing 120 tons swimming at 20 knots, which is comparable to the efficiency of the best marine propeller. Comparison with the power output of human athletes of 1 h.p. per 100 lbs. of muscle showed a dolphin moving at 11½ knots required 1.6 h.p. per 100 lbs. of muscle and at higher speeds of 20 knots and 25 knots would require 8.5 h.p. to 18.6 h.p. per 100 pounds of muscle output by calculation at optimal buoyancy. Other studies concerned oxygen utilization and the higher myohaemoglobin factor necessary to cope with greater respiratory stresses of a marine mammal breathing once a minute.

The conclusion centred on the means of propulsion and the efficiency of the cetacean method in opposition to the sinusoidal oscillation of a swimming fish. A fish presents its greatest surface to the water as it oscillates while the cetacean presents the minimum diameter of its tail and the driving unit is limited to the terminal tail flukes. Stas the Russian zoologist studying the problem noted the tail movement to be somewhat elipsoidal and not entirely vertical, the vertical being the greater diameter to the order of 2:1. There does not seem to be any lateral movement in a large number of cetacea and for many, as well, a negligible effective elipsoidal movement.

Direction-Finding by Sound

Where sound is the basis of direction-finding in the cetacea, as visual acuity range is relatively short, it is of two types. One for group communication as a warning system and the other specifically for echo location.

The social sounds vary for the different species and resemble whistling noises. The asdic type is likened to that of a creaking gate. The location sounds are remarkably efficient, allowing the creature high speed travel whilst avoiding collisions or seeking food.

W N Kellog working in Florida noted the actions of Bottle-Nosed dolphins freely swimming past and even through obstacles He noted their sound signals varied from one to five second intervals They were pulse-like in nature varying from one to two a second to several hundred with the character of the pulse changing with the situation The duration of each pulse wave could be less than one millisecond with the frequency ranging up to 100 K Cs or over Thus the remarkable feature of the sonar sounds was the variation in rate per second intensity and frequency

He found that under normal conditions of rest the dolphin sends out occasional " exploratory pings at 15 20 second intervals When moving however in search of food or stimulated by the splash of a fish or other object in the vicinity there is a marked increase in the ping frequencies If a fish was placed silently in the area the dolphin would fix it in the next ping series and locate it with remarkable accuracy

How the sound pinging is produced has intrigued observers It is believed that the most likely mechanism is the setting of complex soft-walled nasal sacs of the cetacea in vibration (Backhouse, 1960)

Sea Harvesting Research

Ocean currents have a specific and controlling effect on commercial fishing and the shifting abundance and declines are directly linked to the transport by currents of planktonic animals—the principle food for fish shoals

Man too, is a culprit with his primitive fishing techniques which are gradually turning former productive fishing areas into barren marine wastes If deep sea fishing were subject to the same control as a properly stocked and cared for trout lake bigger and better catches would result with less effort and without depleting the shoals It appears however, that international fishery co-operation is as difficult to achieve as peace between primitive warring tribes.

The sea is an enormous storehouse and a potential producer of food for man It has been pointed out that the land becomes relatively more and more impoverished as the population of the world increases and food production at present is too little for world needs The sea could supply the vital protein needed for the under-nourished areas of the world Biologists consider that exploration of the sea for food is still in the amateurish stage as trawling fleets are comparable to nomadic tribal hunters A determined world-wide marine agriculture such as that practised in Japan, China and Malaya, has yet to be developed It is known that nearly 98 per cent of potential fish food in the sea is not eaten by fish but by scavenger creatures such as starfish and sea anemones etc etc Biologists believe " control of these sea pests " would allow a given volume of ocean to support far more fish without disturbing the sea balance Disturbing this balance would end in disaster if embarked upon in haste and without due regard to consequences Press Report 4

Further sea-life studies in Britain are being carried out at the Plymouth Laboratory of the Marine Biological Association of the United Kingdom under the directorship of Dr F S Russell The Association is a private scientific organization supported by a Treasury grant

The Laboratory functioning since 1888 has as its aims to gain fundamental knowledge of conditions in the sea necessary to understand the living processes of food fishes and the marine world in which they flourish In recent years studies with

commercial fisheries have been conducted by the Fisheries Laboratory at Lowestoft.

The Association has a marine research vessel the *Sarsia* of 319 tons, commissioned in 1954 which has a cruising range of 3 000 miles One specific task is to ascertain what deep water conditions are responsible for the periodic changes that take place in the productivity of the waters on the Continental Shelf and more particularly in the Channel

The Laboratory staff of marine biologists has discovered many important physiological facts varying from luminescence patterns of deep sea dwellers light absorption by the retina of eyes of fishes and their visual activity in the depths retinal pigment changes in surface and deep waters, and the chemical state and metabolism of iodine. Press Report 6

A German research vessel the *Anton Dohrn*, investigated the varieties of matter on the deep sea floor as a contribution during the International Geophysical Year Samples taken from a depth of 3 425 metres from the sea floor 700 miles south of Greenland revealed contents of phycomycetes (low fungi forms and high fungi forms) capable of growing on organic materials It was thought that such fungi are selective producers of vitamins in regions where chlorophyll containing plants do not survive, (*New Scientist* 12 5 1960)

(to be continued)

RADIOACTIVITY

By Instructor Lieutenant-Commander H. W. OGDEN, R.N.

PART III

Transmutation and artificial radioactivity

After the nature of alpha particles had been determined they were used by Rutherford to investigate the internal structure of atoms. Such alpha particles were emitted by the naturally radioactive elements such as Polonium, Uranium and Radium.

In 1906 Rutherford had noticed that the image of a metal shape placed between an alpha source and a photographic plate was not clear-cut in its outlines. This fuzziness was attributed by him to the bending of the alpha particle beam by the metal, i.e. to the scattering of the individual particles as they passed through the metal atoms. From theoretical considerations he worked out an equation relating the thickness of the metal, the charge on the scattering nucleus and the velocity of the alpha particle to the angle through which the alpha particle was scattered by the nucleus. The predictions of the equation were experimentally confirmed by Geiger and Marsden.

While they were carrying out this work it was noticed that if hydrogen is subjected to alpha radiation, high speed particles, which were most likely to be protons, were given off. Three years later Rutherford, using very simple apparatus, confirmed the finding of Geiger and Marsden and extended their work to include the bombardment of many light atoms by alpha particles. The apparatus consisted of a metal tube in which was placed the alpha source and the element (in gaseous form), and closed at one end by a thin metal foil screen capable of stopping most of the alpha particles. Outside this screen was a zinc sulphide screen. Zinc sulphide emits scintillations where and when hit by alpha particles. When oxygen or carbon dioxide were introduced into the tube, the number of scintillations on the screen fell off according to the stopping power of the gas for alpha particles, but when dried air was introduced the number of scintillations increased and they were in fact similar to scintillations produced by protons. Further careful study revealed that these particles could only have come from the nitrogen in the air and it was suggested by Rutherford that the protons were coming from the compound nucleus formed when the alpha particle and nitrogen nucleus combine. If this is so, the action can be represented by the following equation in which the symbols have a subscript giving the number of protons in the nucleus (the atomic number) and a superscript giving the number of neutrons and protons (i.e. nucleons) present—(the atomic mass).

$${}_2He^4 + {}_7N^{14} \rightarrow \text{Compound } {}^{18}_{9} \text{ nucleus} \rightarrow \underset{\text{proton}}{{}_1H^1} + {}_8O^{17}$$

If only one proton is given off per compound nucleus, the isotope O^{17} must result

This is known as an alpha-proton process abbreviated to (α p) Between 1920 and 1924 Chadwick and Rutherford showed that all light nuclei between Boron and Potassium with the exception of carbon oxygen and possibly Beryllium undergo this same process The new isotope formed must have an atomic number one greater than the target nucleus whose atomic mass must also increase by three units For heavier nuclei the bombarding alpha particles were scattered presumably because they had insufficient energy to penetrate the potential barrier round the target nucleus The above were the first controlled transmutations of elements

In 1925 Blackett showed by photographing the tracks in a Cloud chamber that the dense track of the alpha particle ended abruptly—where it hit the nitrogen atom nucleus—and the long thin track of a proton emerged at an angle to the short, thick track of the recoiling oxygen nucleus This latter moves so rapidly with energy from the reaction that it is stripped of many orbital electrons and hence is ionized until it has been slowed down sufficiently to pick up its electrons again

Chadwick and Rutherford showed by deflecting the protons in a magnetic field that they had sometimes more energy than the bombarding alpha particle suggesting that the disintegration of the compoud nucleus released energy

In 1928 Gamow showed that an alpha particle is not the best of bullets—a particle, such as the proton with smaller mass and charge has a greater chance of penetrating to the nucleus of a target atom than the alpha particle of equal energy This stimulated the building of machines in which protons could be accelerated through high voltages and in 1932 such a machine caused the disintegration of Lithium by high speed protons The products of disintegration brought about similar scintillations to those produced by alpha particles If they were alpha particles, the reaction can be represented by

$$_1H^1 + _3Li^7 \longrightarrow \begin{matrix}\text{Compound } 8\\ 4 \text{ nucleus}\end{matrix} \longrightarrow {}_2He^4 + {}_2He^4 + \text{Energy}$$

and theory indicates that the reaction should be appreciable if the protons are under a voltage of a quarter of a million volts It also predicts that the two helium nuclei should go in practically opposite directions Photographs of tracks in a Cloud chamber showed that this was indeed the case

It was also shown that the nucleus reacting with the protons—made by subjecting hydrogen gas to high speed electrons which robbed the atoms of their single electrons to leave protons—was Li^7 and not the other stable Lithium isotope Li^6 Cockcroft and Walton measured the energies of the alpha particles If the Einstein equation $E = mc^2$ is true where E is the energy in ergs m the change in mass brought about in the action and c is the velocity of light in cms per second, the energy of the alpha particles should be equivalent to the reduction in mass m as indicated in the equation This was found to be so to within narrow limits of error and the action was the first experimental proof of the equation It was also the first transmutation brought about by experimentally produced particles

Shortly before this in 1930, Bothe and Becker reported that if Beryllium is subject to the high energy alpha particles from Polonium a highly penetrating radiation is given off The Joliot Curies repeated the experiment and then allowed the radiation to impinge on paraffin wax, which is rich in hydrogen atoms They found that protons

were removed from the wax. To account for this they suggested that the alpha particles released a high energy electro-magnetic wave from the Beryllium and that this in its turn reacted with hydrogen nuclei to cause the emission of the protons. This explanation however was contrary to experience—electro-magnetic waves had only been capable of ejecting electrons up to then. Chadwick repeated the experiments and showed that the results could be readily accounted for if it is supposed that the alpha particles released neutrons from the Beryllium, according to the equation

$${}_4Be^9 + {}_2He^4 \longrightarrow \text{Compound nucleus} \longrightarrow {}_0n^1 + {}_6C^{12}$$

The neutron so liberated, being of approximately the same mass as the proton in the hydrogen atom, would impart considerable velocity to it. Thus was the neutron discovered and the above action provides a ready source of neutrons; there are other methods of obtaining them.

The neutrons, being neutral, could be used effectively for bullets, as they would have no potential barrier to surmount on their way into the target nucleus and so would have high penetrating power.

About this time too the Joliot-Curies found that certain light metals, such as Boron, Magnesium and Aluminium give off positrons and neutrons as well as protons when bombarded with alpha particles. This seems quite likely, since a proton could be considered as being composed of a positive positron (i.e. a particle having the same mass as the electron but a positive charge instead of a negative one) and a neutron. In 1934 however it was noticed that the emission of positrons continued after the alpha bombardment had stopped. The conclusion drawn was that the alpha bombardment had produced a radioactive isotope and chemical analysis of the irradiated aluminium showed that the new isotope was one of phosphorus. Its production and decay can be summarized in the following two equations

(i) ${}_{13}Al^{27} + {}_2He^4 \longrightarrow {}_{15}P^{30} + {}_0n^1$

(ii) ${}_{15}P^{30} \xrightarrow[T = 2.55 \text{ mins}]{} {}_{14}Si^{30} + {}_{1}e^0$ positron

The P^{30} is an artificial isotope of phophorus decaying with a half life of nearly 2½ minutes to the stable isotope Si^{30}. The positrons emitted are fairly energetic—3.4 Mev—and would soon be neutralized by electrons with the emission of gamma radiation. It may be as well to recall that in 1932 and 1933 Anderson, Millikan, Blackett and Occhialini had shown that positrons exist, being ejected when cosmic rays act on the materials of the atmosphere.

With boron the actions are —

(i) ${}_5B^{10} + {}_2He^4 \longrightarrow {}_7N^{13} + {}_0n^1$

(ii) ${}_7N^{13} \xrightarrow[T = 10 \text{ mins}]{} {}_6C^{13} + {}_1e^0$

and with magnesium —

(i) ${}_{12}Mg^{24} + {}_2He^4 \longrightarrow {}_{14}Si^{27} + {}_0n^1$

(ii) ${}_{14}Si^{27} \xrightarrow[T = 4.9 \text{ secs}]{} {}_{13}Al^{27} + {}_{+1}e^0$

In this manner were the first artificial radioactive nuclides (species of nucleus) produced. It would be expected that these would be positron emitters, since the

emission of the neutron and the taking in of the doubly charged alpha particle means that the compound nucleus first formed would have an excessive number of positive charges for its neutron content. It would therefore try to reduce the number of protons and increase the number of neutrons. One way in which this can be accomplished is for the proton to decay into a neutron and a positron. It might be objected that this action represented by $_1H^1 \longrightarrow {}_1e^0 + {}_0n^1$ leads to the right hand side having more mass, and therefore energy, than the left hand side since the mass of the proton is 1.00813 a.m.u. while that of the positron is 0.000548 a.m.u. and of the neutron is 1.00894 a.m.u. It must be remembered however that the compound nucleus in which the conversion is taking place has been energized by the fusion of the alpha particle with the target nucleus and that the alpha particle has brought its kinetic energy into the compound nucleus. This energy is mass.

The above action is not represented completely since it is believed that another particle must be given off also. This is the neutrino, experimental evidence for whose existence is not yet conclusive. The question of neutrino formation has already been dealt with in the Spring 1961 issue of this JOURNAL.

As has been suggested above, the first step in a transformation process appears to be the fusing of the target and bombarding nuclei to form the compound nucleus. For this to be achieved the bombarding particle, if positive, must have sufficient kinetic energy to reach a position from which its probability of entry into the nucleus is reasonably high. If the target nucleus is that of a heavy element with large atomic number the barrier will be so much bigger and hence the energy of the particle will have to be so much greater than for the successful bombardment of a lighter nucleus. This increase in energy might be achieved by either increasing the mass or the speed of the particle or both, and therefore it might be thought that the alpha particle having the same speed as a deuteron or proton would be more effective because of its greater mass and hence energy. This however is not so because it has two charges and hence the potential barrier will be so much bigger—its size being proportional to the product of the charge on the target nucleus and that on the particle. There are however other considerations.

If the target nucleus is bombarded with protons there is an increase in energy in the resulting nucleus due to the binding energy liberated in the formation of extra p-n and p-p bonds etc., together with the kinetic energy of the proton. Neglecting this latter we have seen in previous articles that the proton brings roughly 8 Mev of energy to the compound nucleus. The deuteron brings approximately 16 Mev of energy through its proton and neutron. Some of this energy is used in splitting the deuteron up into its proton and neutron—this takes about 2.25 Mev, so that there is a net increase of about 13.75 Mev of energy when deuterons are the bombarding particles. They are therefore likely to cause transformation.

The alpha particle, although it gives about 32 Mev because of its two protons and two neutrons, takes about 28 Mev to separate these from one another. Thus the target nucleus receives only a net 4 Mev approximately in its formation into the compound nucleus. We have seen however that alpha particles do cause transformations.

The neutron brings about 8 Mev to the target nucleus, neglecting the kinetic

energy with which it hits the nucleus It has too no potential barrier to surmount Hence it is likely to cause transformations even at low kinetic energy levels.

What has been said concerning the entry of particles into the target nucleus applies equally to the escape of particles from the compound nucleus In general it is far more difficult for an alpha particle to escape through the potential barrier—it takes about 5½ Mev—than for a neutron or proton Hence if the alpha particle is to escape the bombarding particle must bring more energy either by its nature or by its velocity to the formation of the compound nucleus than is necessary for say, proton or neutron emission

This is however not all the story since it is believed that the nucleons in a nucleus are arranged in energy shells somewhat similar to the way in which orbital electrons are arranged outside the nucleus At certain energies of bombarding particles there is a sudden increase in yield of products from the compound nucleus It seems as if these particle energy levels coincide with the energy levels inside the compound nucleus and set it in oscillation an idea that lies behind the breaking of step as Boy Scouts or troops cross a bridge The number of target nuclei turned into a compound nuclei at these energy levels therefore increases and the yield increases An example of such "wave-mechanical resonance" is seen in the yield from aluminium when bombarded by alpha particles to give protons and the silicon thirty isotope As the energy of the alpha particle is stepped up the yield increases normally, except that at energy levels of 4 0 4 49 5 25 5 75 and 6 61 Mev the yield increases rapidly It looks as if the aluminium nuclei have a greater capacity for alpha capture at these energy levels i e the probability of penetration of the potential barrier is increased

By measuring the ranges of emitted particles it has been possible to show that the particles do not necessarily all come off from their various nuclei in the reacting mass with the same amount of energy It has been shown that for the reaction, $_5B^{10} + _2He^4 \longrightarrow _1H^1 + _6C^{13}$ the protons seem to have five different amounts of energy while those from the reaction given above namely $_{13}Al^{27} + _2He^4 \longrightarrow _1H^1 + _{14}Si^{30}$ occur in four groups each group having protons of a particular energy It is thought that the protons coming off with most energy leave the daughter or recoil nucleus with no excess energy i e in the ground state while those coming off at lower energy values leave the daughter nucleus with some excess energy This is shed as gamma radiation as the daughter nucleus settles down to the ground state

This ejection of a particle followed by gamma radiation is particularly prevalent when the decay is by beta emission About half of the beta emitters also radiate gamma radiation from their daughter nuclei

It has been postulated by Niels Bohr of Denmark that when a projectile enters the target nucleus its energy is rapidly shared between the nucleons present Eventually one or more nucleons have sufficient energy obtained from their energized neighbours to escape All this takes time a time estimated at about 10^{-12} to 10^{-14} seconds Short though this is it is long compared with the time taken by a nucleon to travel across the nucleus whose diameter is about 10^{-12} cms There is thus plenty of time for the nucleons to distribute their energies amongst one another

It is possible for the same compound nucleus to be formed in more than one way

For example the compound nucleus $_9X^{18}$, a fluorine isotope, can be formed as follows: —

$_7N^{14} + {_2He^4} \qquad\qquad {_9X^{18}}$
$_8O^{16} + {_1D^2} \qquad\qquad {_9X^{18}}$
$_8O^{17} + {_1H^1} \qquad\qquad {_9X^{18}}$

Depending on the way it is produced this compound nucleus will have different amounts of energy. It would therefore be expected, in general, to disintegrate in different ways depending on the amount of energy available. It is possible for the compound nucleus to split in two different ways simultaneously, i.e. if a mass of target material is subject to bombardment resulting in the formation of compound nuclei in the mass, some will then split up one way while others split up another way. Which way predominates usually depends upon the energies of the compound nucleus. At low energies it splits up mainly by one kind of action, while at higher energy levels another method of splitting up predominates. For example, if deuterons bombard Cu^{63}, $_{30}Zn^{65}$ may be formed. If the deuteron has a low energy level, the Zn^{65} then appears to give $_{29}Cu^{64} + {_1H^1}$. This is probably due to the deuteron particle being split up, as it approaches the Cu^{63} nucleus, by the electrostatic repulsion between the nucleus and the proton in the deuteron. The proton carries on and is deflected away from the nucleus, while the neutron passes into the nucleus. This gives insufficient energy for the compound nucleus to give anything but gamma radiation. The deuteron must have at least 2.25 Mev of energy for the electric field to split the deuteron as it approaches. At higher energies the deuteron probably enters the copper nucleus to form the compound zinc nucleus, which then gives Cu^{64} and the proton. At the same time another process also occurs at higher deuteron energies, namely —

$_{30}Zn^{65} \longrightarrow {_{30}Zn^{63}} + 2\,{_0n^1}$

Enough has been said, it is hoped, to show that the results of bombardment depend on many factors. A final factor, which depends on nuclear structure, is the nature of the nucleus that is going to be produced by bombardment, as well as the nature of the nucleus being bombarded. It is found that certain numbers of neutrons and protons in a nucleus confer on it extra stability, presumably in a similar way that certain numbers of electrons in an energy shell give it stability. These numbers are 2, 8, 20, 50, 82 and 126; the stability they give can be accounted for if the spins of the protons and neutrons are taken into account.

For example, for bombarding neutrons of 1 Mev kinetic energy, nuclei having 50, 82 or 126 neutrons present already are very loathe to add to their number, and if the bombarding neutron has very low energy (a thermal neutron) the target nucleus showing stability will be one having 20 as well as the above numbers of neutrons present. These nuclei do not therefore react readily with the bombarding neutrons. If the nucleus has one more neutron than a stable number, such as $_8O^{17}$, which has one more neutron than 8, this extra neutron is ejected on the slightest excitation. (See Spring 1961 issue of this Journal.)

The reactions of particles with nuclei can be classified under many headings. It is proposed to describe some of the reactions which are considered important by throwing fresh light on atomic structure or which are of importance medically.

1. Neutron-Gamma (n, γ) processes. These are very common and take place

[illegible] slow neutrons. In the process the neutron [illegible] the compound nucleus formed has [illegible] sufficient energy [illegible]. Such a process is called "radiative capture".

The addition [illegible] almost bound to make the compound nucleus a beta emitter since [illegible] have too many neutrons for stability. Accompanying the beta [illegible] may also be gamma radiation as mentioned earlier; the beta decay will give a final nucleus whose atomic number is one greater than the original target nucleus. In the equations below those marked (i) represent the formation of the compound nucleus—an isotope of the target nucleus and therefore chemically inseparable—while those marked (ii) represent the radioactive decay of the compound nucleus. The half life T, as well as the energies of the beta particles and gamma rays are also given. The value of these can be assessed from the knowledge that a radioactive species of cobalt^{60} having a half life of 5.3 years, emits beta particles of 0.31 Mev and gamma radiation of 1.1171 and 1.3318 Mev. If the amount of such cobalt^{60} present is such as to give 3.7×10^{10} disintegrations per second, i.e. one curie of Co^{60} is present, then the rate of radiation dose received at a distance of one metre is 1.35 roentgens per hour. A worker with radioactive materials is not supposed to recieve more than 3 roentgens in a 13 week period and must not accumulate a dose of more than 5 roentgens in each year if he or she is over 18 years of age, i.e. he or she must not receive a greater steady dose than 0.1 roentgen per working week of 40 hours. Actually the units are REMS, but for soft body tissue 1 REM is approximately equal to 1 roentgen for gamma radiation.

1. a. (i) ${}_{11}Na^{23} + {}_{0}n^{1} \longrightarrow {}_{11}Na^{24} +$ gamma

(ii) ${}_{11}Na^{24} \xrightarrow[T\,=\,14.8\ \text{hrs}]{} {}_{12}Mg^{24} + {}_{-1}e^{0}$ (1.39 Mev) + gamma (1.38, 2.76 Mev)

Since sodium is present in sea water, soil and body fluids, such events are likely to occur wherever there are even slow neutrons.

1. b. (i) ${}_{15}P^{31} + {}_{0}n^{1} \longrightarrow {}_{15}P^{32} +$ gamma

(ii) ${}_{15}P^{32} \xrightarrow[T\,=\,14\ \text{days}]{} {}_{16}S^{32} + {}_{-1}e^{0}$ (1.7 Mev)

1. c. (i) ${}_{26}Fe^{58} + {}_{0}n^{1} \longrightarrow {}_{26}Fe^{59} +$ gamma

(ii) ${}_{26}Fe^{59} \xrightarrow[T\,=\,46.3\ \text{days}]{} {}_{27}Co^{59} + {}_{-1}e^{0}$ (0.255, 0.46 Mev) + gamma (1.1, 1.3 Mev)

1. d. (i) ${}_{1}H^{1} + {}_{0}n^{1} \longrightarrow {}_{1}D^{2} +$ gamma (energy $\approx$ 2.25 Mev)

Each of the above elements is essential to life and occurs universally in living tissue; each is also widely distributed on the surface of the earth. It is to be seen that the last reaction only gives gamma radiation while the neutron bombardment is taking place. This is constantly happening due to the action of cosmic rays on the atmospheric material, which produces neutrons and which in their turn give heavy water from the water already present. Deuterium is not radioactive.

It can be seen from the above that the actions result in elements of completely different chemical and physical properties. What effect this may have is not known to the writer. It may have little effect unless the neutron flux is sufficiently high to change an appreciable amount of the elements present in the body; the physiological effect on such fundamental processes as respiration of changing the phosphorus

to sulphur must be considerable if the concentration [illegible]

A reaction that is of considerable value to the world [illegible] slow neutrons or [illegible] calls slow neutrons (0 03 Mev) [illegible] the U^{238} which is present to the extent of 0 7 per cent in U^{238} [illegible] combines with U^{238} to give U^{239} This is radioactive emitting a beta particle [illegible] Neptunium-239 and then Plutonium-239 This latter is a fissile material and so it is possible to breed Pu^{239} from non fissile (with slow neutrons) U^{238} This increases the supply of fissile fuel if more than one atom of Pu^{239} is produced by the breakdown of a U^{235} atom in the breeder reactor

1 e (i) ${}_{92}U^{238} + {}_{0}n^{1} \longrightarrow {}_{92}U^{239} + \text{gamma}$

(ii) ${}_{92}U^{239} \longrightarrow {}_{93}Np^{239} + {}_{1}e^{0} + e^{-1} + \text{gamma}$ (0 076 0 92 Mev)

T 23 5 mins (0 56 and 1 6 Mev)

Here some of the gamma radiation (photons) are knocking out electrons (e^{-1}) from the orbits round the nucleus and being annihilated in the process—internal conversion process The neptunium gives —

(iii) ${}_{93}Np^{239} \longrightarrow {}_{94}Pu^{239} - {}_{1}e^{0} - e^{-1} - \text{gamma}$ (0 057–0 275 Mev)

T –2 33 days (0 288 to 1 179 Mev)

The only difference between ${}_{1}e^{0}$ and e^{-1} is in their place of origin—they are both electrons

Other neutron gamma processes that are of importance are those involving soil elements which have not been given above such as manganese and silicon the former is a necessary trace element in plants

1 f (i) ${}_{25}Mn^{55} + {}_{0}n^{1} \longrightarrow {}_{25}Mn^{56} + \text{gamma}$

(ii) ${}_{25}Mn^{56} \longrightarrow {}_{26}Fe^{56} + {}_{1}e^{0}$ (0 75 to 2 81 Mev) + gamma (0 82 to 2 06 Mev)

T –2 6 hours

1 g (i) ${}_{14}Si^{28-30} + {}_{0}n^{1} \longrightarrow {}_{14}Si^{31} + \text{gamma}$

(ii) ${}_{14}Si^{31} \longrightarrow {}_{15}P^{31} + {}_{1}e^{0}$ (1 8 Mev)

T –170 mins

Two nuclear reactions involving important halogens are —

1 h (i) ${}_{17}Cl^{37} + {}_{0}n^{1} \longrightarrow {}_{17}Cl^{38} + \text{gamma}$

(ii) ${}_{17}Cl^{38} \longrightarrow {}_{18}A^{38} + {}_{1}e^{0}$ (1 1 4 8 Mev) + gamma (1 6–2 12 Mev)

T –38 5 mins

Again the effect of changing active chlorine probably as chlorine ions into inert argon must have profound physiological effects if the concentration is high

1 i (i) ${}_{52}Te^{130} + {}_{0}n^{1} \longrightarrow {}_{52}Te^{131} + \text{gamma}$

(ii) ${}_{52}Te^{131} \longrightarrow {}_{53}I^{131} + {}_{1}e^{0} - e^{-1} + \text{gamma}$ (0 08 0 367 Mev)

T –30 hrs 25 mins (0 25 0 595 Mev)

—see nuclear isomerism later

This action allows carrier free iodine[131] to be prepared for use in research

2 Neutron proton (n p) processes

The neutron must in general be a little more energetic to enable the proton to escape through the potential barrier The addition of a neutron and the loss of the lighter proton means

a the mass of the product is more than the mass of the reactant nucleus and the energy liberated—the reaction energy—may therefore be negative To bring

the mass of the reactants to a value at which the action can take place, the neutron kinetic energy must reach a threshold value. Above this value the yield increases normally with increasing energy of the neutron. With light nuclei however as targets the reaction energy is positive and with these nuclei the potential barrier is not large. The action can therefore take place with light nuclei at quite low neutron energies.

2. the nucleus formed after the proton has been expelled from the compound nucleus must have its atomic number reduced by one compared with the atomic number of the target nucleus. It will also have one more neutron and hence will be over stocked with neutrons and will therefore most likely be a beta (and possibly gamma) emitter.

A reaction that is constantly taking place in the atmosphere due to cosmic ray activity is the formation of neutrons from atoms in the air. These neutrons can then react with nitrogen and give carbon[14] with proton emission —

2. a. (i) $_{7}N^{14} + {}_{0}n^{1} \longrightarrow \begin{matrix}\text{Compound } 15 \\ 7 \text{ nucleus}\end{matrix} \longrightarrow {}_{1}H^{1} + {}_{6}C^{14}$

(ii) $_{6}C^{14} \xrightarrow[T\ 5\,513 \text{ years}]{} {}_{7}N^{14} + {}_{-1}e^{0}$ (0.158 Mev)

It is frequently suggested that this radioactive carbon is absorbed by plants as carbon dioxide but it is not stated how molecular atmospheric nitrogen becomes carbon dioxide after neutron bombardment. It could be that in this bombardment one nitrogen atom of the pair in a molecule becomes C^{14} resulting in the breaking of the bonds holding the molecule together. This would mean C^{14} (and N^{14}) being in the atomic state. As such they might be oxidised but there are other possibilities such as CO in which the oxygen is the isotope O^{17}, already shown to be ready to give up its extra neutron giving up the neutron to the carbon[13] to give carbon[14]. All this however is just speculation.

Carbon[14] is a useful research tool and it is made for this purpose by exposing beryllium nitride to the neutron flux in a power reactor. The nitrogen is converted to C^{14} as above and is then extracted as carbon dioxide and absorbed in baryta to give barium carbonate as a precipitate.

2. b. (i) $_{17}Cl^{35} + {}_{0}n^{1} \longrightarrow {}_{16}S^{35} + {}_{1}H^{1}$

(ii) $_{16}S^{35} \xrightarrow[T\ 87 \text{ days}]{} {}_{17}Cl^{35} + {}_{-1}e^{0}$ (0.167 Mev)

It can be seen that both of the naturally occurring chlorine isotopes react with neutrons to form radioactive products.

2. c. (i) $_{13}Al^{27} + {}_{0}n^{1} \longrightarrow {}_{12}Mg^{27} + {}_{1}H^{1}$

(ii) $_{12}Mg^{27} \xrightarrow[T\ 9.6 \text{ mins}]{} {}_{13}Al^{27} + {}_{-1}e^{0}$ (0.79, 1.8 Mev) + gamma (0.835, 1.01 Mev)

2. d. (i) $_{12}Mg^{24} + {}_{0}n^{1} \longrightarrow {}_{11}Na^{24} + {}_{1}H^{1}$

(ii) $_{11}Na^{24} \xrightarrow[T\ 14.8 \text{ hrs}]{} {}_{12}Mg^{24} + {}_{-1}e^{0}$ (1.39 Mev) + gamma (1.38, 2.76 Mev)

Both the above elements are widely distributed on the surface of the earth and magnesium apart from being the essential metal in the chlorophyll molecule is also next to sodium in abundance amongst the metals in sea water.

It appears from the reactions already given that the neutron is being changed into a proton and beta particle. The energy output of this action ($_0n^1 \rightarrow$ $_1H^1 + {}_{-1}e^0$ + neutrino) is 0.78 Mev. Thus the sum of the energies of the reactions (i) and (ii) given above for each target nucleus must equal this figure. If the energy of the beta particles (and gamma radiation) is greater than this the reaction energy of the (i) reactions must be negative. This is so with the heavy nuclei as already indicated but is not so with light nuclei.

A further point is that the radioactive daughter nuclei are chemically different from the target nuclei and hence can be separated chemically to give a high specific activity, i.e. activity per gram of material.

A reaction which may be of biological significance, apart from those already given is—

(i) $_{16}S^{32} + {}_0n^1 \longrightarrow {}_{15}P^{32} + {}_1H^1$

(ii) $_{15}P^{32} \xrightarrow[T = 14.07 \text{ days}]{} {}_{16}S^{32} + {}_{-1}e^0$ (1.704 Mev)

3. Neutron alpha (n, α) processes

Although the neutron would find it easy to get into the target nucleus the alpha particle would have some difficulty in escaping unless the neutron were sufficiently energetic. Less neutron energy would be needed for light target nuclei than for those with a large atomic number.

An example of this process involving a light nucleus is the reaction of slow neutrons with Boron—usually in the form of the gas boron trifluoride

$_5B^{10} + {}_0n^1 \longrightarrow {}_3Li^7 + {}_2He^4$

Neutrons cannot make their presence known except by producing some charged particle which can then create an electric current or produce a flash of light in some phosphor such as zinc sulphide. The reaction just given is used to detect and measure neutron flux as the alpha particles can either give scintillations in a scintillation counter or an electric current in an ionization chamber.

A reaction which is much used in scintillation counters for detecting neutrons is

$_3Li^6 + {}_0n^1 \longrightarrow {}_1H^3 + {}_2He^4$

Li^6 is present in natural lithium to the extent of only about 7 per cent but it has a high cross-section for neutron capture. This means that it readily captures and reacts with neutrons. The resultant tritium and helium nuclei recoiling at high speed produce scintillations as their kinetic energy is lost. Thus lithium iodide is used as a neutron phosphor.

Other (n, α) processes are given below. It will be seen that the transmutation involves the loss of two protons and one neutron. Hence the daughter nucleus left after alpha emission will have a greater neutron-to-proton ratio than the stable target nucleus. It will therefore be likely to emit beta particles by changing a neutron to a proton.

3 a (i) $_9F^{19} + {}_0n^1 \longrightarrow {}_7N^{16} + {}_2He^4$

(ii) $_7N^{16} \xrightarrow[T = 7.35 \text{ secs}]{} {}_8O^{16} + {}_{-1}e^0$ (3.5, 6.2, 7.0 Mev) + gamma (5.1 to 6.7 Mev)

3 b (i) $_{30}Zn^{68} + {}_0n^1 \longrightarrow {}_{28}Ni^{65} + {}_2He^4$

(ii) $_{28}Ni^{65} \xrightarrow[T = 2.5 \text{ hrs}]{} {}_{29}Cu^{65} + {}_{-1}e^0$ (0.44, 1.01, 1.97 Mev) + gamma (0.3, 1.12, 1.64 Mev)

[illegible] $\rightarrow {}_{11}Na^{24}$ + He[illegible]

The Na^{24} then decays as already seen. This last [illegible] Na^{24} can be made by the three methods already discussed.

The (n, α) process is rare with target nuclei having atomic numbers greater than 40. Generally, if the neutron has enough energy to make the (n, α) process possible other processes such as (n, 2n) take place in preference.

Neutrons can react with nuclei in three other ways, namely elastic scattering, inelastic scattering and in fission processes.

In the elastic scattering of neutrons the event is just like a collision between two spheres in that momentum and energy may be conserved. It is possible to determine mathematically how much energy is lost in each collision between a neutron and a given type of nucleus for each type of collision, head on, glancing, etc. It can be shown that the number of collisions necessary to thermalize 1 Mev neutrons, i.e. reduce the kinetic energy to that of the surrounding atoms, etc., at normal temperatures, is with hydrogen as the target nucleus—18, with deuterium 25, with helium 42, with beryllium 90, with carbon 114 and with oxygen 150. Thus hydrogen and deuterium have a high stopping power for neutrons. On the other hand hydrogen has the disadvantage that it also captures quite a number of neutrons to give deuterium. What is apparent, however, is that light nuclei are better neutron shields than heavy nuclei.

In inelastic scattering the high energy neutron enters the target nucleus, which it energizes, and from which a neutron of lower energy is emitted. The balance of the energy is retained in the target nucleus and is then liberated as gamma radiation. The phenomenon of fission will be considered later.

4. Proton gamma (p, γ) processes. (Radiative capture.)

This has been observed with light nuclei, the energy of the gamma radiation being quite high. In the action ${}_3Li^7 + {}_1H^1 \longrightarrow {}_4Be^8$ + gamma, the energy liberated is about 17 Mev. The ${}_4Be^8$ exists for a very short time before splitting up into two helium nuclei. The high energy gamma radiation has been used to uncover a detail of atomic structure.

If bromine, consisting of the isotopes Br^{79} and Br^{81}, is subject to neutron bombardment, (n, γ) processes take place resulting in the formation of Br^{80} and Br^{82}. These are, as would be expected, beta emitters, but on measuring the half lives, it is found that three kinds of beta emitter are present, since there are three half lives—18 minutes, 4.5 hours and 36 hours. The deduction to be drawn is that either Br^{80} exists in two beta emitting forms, or Br^{82} does. If now the Br^{79} and Br^{81} isotopes are subject to gamma radiation of high enough energy, a neutron can be ejected to give Br^{78} and Br^{80}. These are radioactive and again show three half-lives—6.4 minutes, 18 minutes and 4.5 hours. The common isotope resulting from bombardment is Br^{80}, to which must be ascribed the two half-lives that are also common, namely 18 minutes and 4.5 hours. The Br^{80} is said to exist in two isomeric forms and it is possible for one form, of higher energy, to change into the lower energy state of the other isomeric form, with the emission of gamma rays. This change however may be very difficult, in which case the higher energy forms undergo radioactive decay independently to give a common stable end product.

The change from the higher to the lower energy state is known as "internal transition". The gamma rays given off frequently undergo internal conversion within the atom, in which they act as particles knocking orbital electrons out of the atom and being annihilated in the process. This may lead to X radiation since the hole left by the electron can then be filled by an electron in a higher energy orbit jumping inwards to the deficient orbit and giving off an X ray quantum. The higher and lower energy isomers are known as "genetically related isomers" and are exemplified by the Br^{80}. Other examples are given by $_{52}Te^{131}$ and Co^{60}. The higher energy state of this latter has a half-life of 10 7 minutes giving off beta particles of 1 35 Mev and gamma of 0 058 and 1 32 Mev some of the gamma rays being internally converted with the emission of an orbital electron. The lower energy state of Co^{60} has a half life of 5 3 years and emits 0 31 Mev beta particles as well as 1 1171 and 1 3316 Mev gamma radiation.

5 Proton neutron (p, n) processes

The probability of this type of reaction occurring is high particularly if the proton has certain energy values, due to the resonance effects already described. Exchanging a neutron for a proton is going to lower the neutron-to proton ratio and hence the daughter nucleus is likely to be radioactive particles being emitted to try and reduce the nuclear charge and increase the neutron count in the nucleus. This can be accomplished by positron emission K capture or alpha emission as mentioned in the second article.

Examples of this type of transmutation are given below —

5 a (i) $_{11}Na^{23}+_{1}H^{1} \longrightarrow _{12}Mg^{23}+_{0}n^{1}$

(ii) $_{12}Mg^{23} \longrightarrow _{11}Na^{23}+_{+1}e^{0}$ (2 82 Mev)

T 11 6 secs

5 b (i) $_{8}O^{18}+_{1}H^{1} \longrightarrow _{9}F^{18}+_{0}n^{1}$

(ii) $_{9}F^{18} \longrightarrow _{8}O^{18}+_{+1}e^{0}$ (0 635 Mev)

T = 112 mins

Here the oxygen[18] normally present in oxygen to the extent of about 0 2 per cent is changed into radioactive fluorine. The radioactivity is readily detectable even with relatively insensitive instruments.

Protons are easily prepared in the laboratory by electron stripping of hydrogen atoms by fast electrons on their way to a positive anode. Neutrons are not easily obtained however. The next two reactions can be used to obtain a laboratory supply of neutrons

5 c (i) $_{4}Be^{9}+_{1}H^{1} \longrightarrow _{5}B^{9}+_{0}n^{1}$

5 d (i) $_{3}Li^{7}+_{1}H^{1} \longrightarrow _{4}Be^{7}+_{0}n^{1}$

In the first of these last two reactions the B^{9} has a very short life (about 3×10^{-19} seconds) before splitting up to give a proton and two helium nuclei or alpha particles. The Be^{7} is also radioactive emitting gamma rays due to the capture of an orbital electron (K capture) by the nucleus to give the stable $_{3}Li^{7}$ nucleus again. Its half life is 53 days.

The (p n) reactions given above require rather more energetic particles than would be the case if neutrons were being used as "bullets" because the proton has to overcome the force of repulsion between itself and the target nucleus. This force would be

bigger the larger the atomic number of the target and [illegible] likely with light nuclei as targets

Reactions of the (p α) and proton deuteron types are known but are unlikely with heavy nuclei because of the difficulties of the proton entering the nucleus and the deuteron and alpha particle escaping One has already been described namely that of Cockcroft and Walton in which they bombarded Li^7 and obtained two helium nuclei Another is shown in the equation below and of course is of importance when protons possibly liberated by neutrons as already described are present in the soil

$$_{13}Al^{27} + {}_1H^1 \longrightarrow {}_{12}Mg^{24} + {}_2He^4$$

The magnesium is not radioactive and so the only danger would be radioactivity induced by the alpha particle unless of course the alpha particle itself could be dangerous

A rare proton deuteron reaction is

$$_4Be^9 + {}_1H^1 \longrightarrow {}_4Be^8 + {}_1H^2$$

Protons can excite target nuclei in two other ways The first way is by inelastic scattering in which the proton enters the target nucleus and excites it The resulting compound nucleus then ejects a proton of lower energy The daughter nucleus left will have residual energy which will be emitted as gamma radiation when the nucleus settles down to the ground state

The second way is by Coulomb or electrostatic excitation As the proton approaches the target nucleus the latter becomes excited through the electrostatic field existing between the two positively charged bodies The energy thus gained by the target nucleus will be emitted as gamma radiation after the proton has been deflected away

6 Alpha-neutron processes

Some of these have already been described in tracing the history of artificially induced transmutations and radioactivity Suffice it to say that they are unlikely except for light nuclei since the alpha particle carries two charges When the actions do take place the resulting nucleus will be a positron emitter as two protons but only one neutron have been added to the target nucleus Alpha particles can excite the nucleus by inelastic scattering and by electrostatic excitation

7 The deuteron is a very effective bullet as has already been explained Protons neutrons tritons (tritium nuclei) and alpha particles may all result from deuteron bombardment. Deuteron proton reactions are common and have already been touched upon The compound nucleus, after ejecting the proton will have an excess of neutrons and may well be a beta emitter In the reaction $_{83}Bi^{209} + {}_1D^2 \longrightarrow {}_{83}Bi^{210} + {}_1H^1$ the Bi^{210} is the same as radium E and is an alpha emitter

Deuteron neutron processes are also common and may be used as a source of neutrons e.g. $_3Li^6 + {}_1D^2 \longrightarrow {}_4Be^7 + {}_0n^1$ As would be expected the product is radioactive in the above case by K capture, in which an excess proton in the nucleus is neutralized by a K shell orbital electron with the emission of gamma radiation

Some deuteron reactions are of importance in that they result in larger nuclei with the liberation of energy For example —

a $_1D^2 + {}_1D^2 \longrightarrow {}_2He^3 + {}_0n^1 + 3.2$ Mev

b $_1D^2 + {}_1D^2 \longrightarrow {}_1H^3 + {}_1H^1 + 4$ Mev

c $_1D^2 + {}_1H^3 \longrightarrow {}_2He^4 + {}_0n^1 + 17.6$ Mev

b Transmutation by electrons and radiation

These are not very common since the energy needed to drive out a nucleon from a fairly large nucleus is about 8 Mev Thus the radiation must be quite energetic to bring the reactions about One with 17 Mev gamma radiation, has already been described in connection with isomerism in Br^{80} With Be^9 gamma radiation can also bring about neutron emission because the binding energy of Be^9 is low

$${}_4Be^9 + \text{gamma} \longrightarrow {}_4Be^8 + {}_0n^1$$

The Be^8 rapidly disintegrates into two helium particles

For electrons the probability of nuclear entry is small and only one or two transmutations by electrons have been reported

(*to be continued*)

DENTAL HEALTH IN ADOLESCENCE—NEW-ENTRY TABLES

By Surgeon Commander (D) W E STARKEY, R N

CERTAIN aspects of the new-entry dental survey carried out in the Royal Navy during 1958 and 1959 have already been discussed elsewhere (Starkey 1961) but only findings affecting the prevalence of dental caries were considered and the full results are now presented for the first time The survey involved 21,740 recruits of all eligible categories and ages It was conducted as a part of the joining routine at ten training establishments concerned with the reception of new entries During the period under review no minimum dental standards and no previous examination were required on entry so that the results can be regarded as a fair sample of the conditions existing in an adolescent civilian population drawn from all parts of the United Kingdom

For two years beginning December 1957 the dental condition of all entrants was recorded according to age category and sex Examinations were carried out with mirror and probe, and supplemented with bite wing X-rays as required Mouths were charted for teeth missing unerupted filled, decayed or requiring extraction cavities and fillings were recorded in relation to the tooth surfaces involved and sticky fissures were counted as carious The separate aggregates were returned to the Royal Naval Medical School for correlation

The following tables are arranged to permit the separate study of four categories (a) Dartmouth Cadets (b) Apprentices of all trades (c) W R N S personnel (d) All other types of new entry These are sub divided into five age groups ranging from 15 to over 19 years, making it possible by cross reference to compare the results in terms of social background educational standards and sex or age Tables IA and IB summarize the aggregate dental conditions and averages for the total intake

REFERENCE

STARKEY W E (1961) *Brit dent J* 112 69

All Age Groups and Categories entering the Royal Navy between 1st December, 1957, and 30th November, 1959

TABLE IA

Aggregates

Number examined	21 740
Needing treatment	20 131
Wearing satisfactory dentures	901
Wearing unsatisfactory dentures	412
Needing new dentures	1 820
Needing scaling and/or periodontal treatment	7 833
Without previous treatment	2 623
Without caries experience	55
Teeth needing fillings	108 584
Teeth previously filled	90 251
Teeth previously filled needing fillings	14,142
Teeth previously filled needing extraction	787
Teeth needing extraction	11,216
Teeth previously extracted	52 806

TABLE IB

Per 100 Patients

Needing treatment	92 5
Wearing satisfactory dentures	4 14
Wearing unsatisfactory dentures	1 89
Needing new dentures	8 37
Needing scaling and/or periodontal treatment	36 0
Without previous treatment	12 0
Without caries experience	0 25
Teeth needing fillings	499
Teeth previously filled	415
Teeth previously filled needing fillings	65
Teeth previously filled needing extraction	4 0
Teeth needing extraction	515
Teeth previously extracted	247
Average individual D M F	12 12

Dartmouth Cadets aged 18 19 entering the Royal Navy between 1st December, 1957, and 30th November 1959

TABLE IIA

Aggregates

Number examined	[illegible]
Needing treatment	185
Wearing satisfactory dentures	6
Wearing unsatisfactory dentures	
Needing new dentures	—
Needing scaling and/or periodontal treatment	6
Without previous treatment	2
Without caries experience	2
Teeth needing fillings	510
Teeth previously filled	2 471
Teeth previously filled needing fillings	104
Teeth previously filled needing extraction	—
Teeth needing extraction	1
Teeth previously extracted	263

TABLE IIB

Per 100 Patients

Needing treatment	67 7
Wearing satisfactory dentures	2 19
Wearing unsatisfactory dentures	—
Needing new dentures	—
Needing scaling and/or periodontal treatment	2 19
Without previous treatment	0 73
Without caries experience	0 73
Teeth needing fillings	186
Teeth previously filled	905
Teeth previously filled needing fillings	0 38
Teeth previously filled needing extraction	—
Teeth needing extraction	0 004
Teeth previously extracted	93
Average individual D M F	11 87

Recruits entering the Royal Navy between 1st December, 1957, and 30th November, 1959—excluding Officers, Apprentices and Wrens

TABLE IIIA	Aggregates				
	Under 16	16–17	17–18	18–19	Above 19
Number examined	4 795	3 511	4 168	2 826	3 257
Needing treatment	4 636	3 354	4 025	2 683	2 845
Wearing satisfactory dentures	73	120	164	132	233
Wearing unsatisfactory dentures	57	51	74	65	126
Needing new dentures	283	205	476	347	429
Needing scaling and/or periodontal treatment	2 173	755	1 534	1 078	1 328
Without previous treatment	427	464	785	409	423
Without caries experience	15	10	7	5	8
Teeth needing fillings	28 954	17 438	21 148	13 628	17 765
Teeth previously filled	16 712	11 783	12 319	9 095	19,297
Teeth previously filled needing fillings	4 016	2 121	2 127	1 486	2 668
Teeth previously filled needing extraction	249	100	182	66	104
Teeth needing extraction	3 243	1 652	2 231	1 561	1 879
Teeth previously extracted	7 135	7,004	10 063	7 735	13 215

TABLE IIIA	Per 100 Patients				
	Under 16	16–17	17–18	18–19	Above 19
Number examined	4 795	3 511	4 168	2 826	3 257
Needing treatment	96.6	95.5	97.6	94.9	87.3
Wearing satisfactory dentures	1.5	3.41	3.93	4.67	7.15
Wearing unsatisfactory dentures	1.2	1.45	1.77	2.33	3.86
Needing new dentures	5.9	5.83	11.4	12.2	13.1
Needing scaling and/or periodontal treatment	45.3	21.5	36.8	38.1	40.7
Without previous treatment	8.9	13.2	18.8	14.4	12.9
Without caries experience	0.31	0.28	0.17	0.18	0.24
Teeth needing fillings	604	496	507	482	545
Teeth previously filled	348	325	295	321	592
Teeth previously filled needing fillings	84	65	51	52	82
Teeth previously filled needing extraction	5	3	4	2	3
Teeth needing extraction	67	47	53	55	57
Teeth previously extracted	148	199	241	273	405
Average individual D M F	11.67	10.67	10.96	11.31	15.99

Apprentices entering the Royal Navy between 1st December, 1957, and 30th November, 1959

TABLE IVA

Aggregates

	Under 16	16–17	17–18
Number examined	176	653	37
Needing treatment	168	634	[illegible]
Wearing satisfactory dentures	3	18	2
Wearing unsatisfactory dentures	1	2	—
Needing new dentures	7	27	4
Needing scaling and/or periodontal treatment	51	168	22
Without previous treatment	8	23	3
Without caries experience	1	2	—
Teeth needing fillings	762	2,906	162
Teeth previously filled	1,216	3,813	195
Teeth previously filled needing fillings	126	378	19
Teeth previously filled needing extraction	18	42	5
Teeth needing extraction	72	108	7
Teeth previously extracted	287	994	79

TABLE IVB

Per 100 Patients

	Under 16	16–17	17–18
Number examined	176	653	37
Needing treatment	95·4	97	81
Wearing satisfactory dentures	1·71	2·75	5·40
Wearing unsatisfactory dentures	0·57	0·31	—
Needing new dentures	3·99	4·13	10·81
Needing scaling and/or periodontal treatment	28·9	25·7	59·4
Without previous treatment	4·56	3·52	8·12
Without caries experience	0·57	0·31	—
Teeth needing fillings	432	445	438
Teeth previously filled	690	583	527
Teeth previously filled needing fillings	71	58	51
Teeth previously filled needing extraction	10·2	6·0	13·0
Teeth needing extraction	41	16	19
Teeth previously extracted	158	152	213
Average individual D M F	13·21	11·96	11·97

Wrens entering the Royal Navy between 1st December 1957, and 30th November 1959

TABLE Va

Aggregates

	17–18	18–19	Above 19
Number examined	701	526	590
Needing treatment	566	425	450
Wearing satisfactory dentures	27	46	65
Wearing unsatisfactory dentures	9	8	16
Needing new dentures	8	10	17
Needing scaling and/or periodontal treatment	235	235	200
Without previous treatment	33	26	13
Without caries experience	1	4	—
Teeth needing fillings	1 573	1 748	1 571
Teeth previously filled	4 167	3 612	4 298
Teeth previously filled needing fillings	349	311	294
Teeth previously filled needing extraction	2	5	1
Teeth needing extraction	162	104	110
Teeth previously extracted	2 161	1 753	2 575

TABLE Vb

Per 100 Patients

	17–18	18–19	Above 19
Number examined	701	526	590
Needing treatment	80·7	80·8	76·2
Wearing satisfactory dentures	3·85	8·74	11·0
Wearing unsatisfactory dentures	1·28	1·52	2·7
Needing new dentures	1·14	1·9	3·8
Needing scaling and/or periodontal treatment	33·5	44·6	33·9
Without previous treatment	4·7	4·9	2·2
Without caries experience	·14	·75	—
Teeth needing fillings	224	332	266
Teeth previously filled	594	686	728
Teeth previously filled needing fillings	49	59	49
Teeth previously filled needing extraction	0·3	0·9	0·2
Teeth needing extraction	23·1	19·7	18·6
Teeth previously extracted	308	333	436
Average individual D M F	11·49	13·70	14·49

A STUDY OF CARIES RESISTANCE IN THE BRITISH ARMED FORCES

By Surgeon Commander (D) W. E. STARKEY, R.N.

ALTHOUGH the Dental Branches of the Armed Forces in Great Britain remain loyaly attached to their respective services, they are capable of acting as one when the occasion demands.

Recently they have concluded the first part of a joint survey in caries resistance in young adults that would have been beyond the scope of any one of them, or indeed beyond that of any other public health authority in the United Kingdom. Data concerning dental health, as distinct from dental disease, are difficult to come by. Yarboroughs are as rare in dentistry as in Bridge, and are as seldom declared. Uncharted populations existing outside professional scrutiny either require no treatment at all or contrive to do without it. The problem is to find out which of them is which. The teeth of persons with no decay are seldom seen again once they have left school except when they become the responsibility of the Forces of the Crown whose surveillance falls impartially on the just and unjust alike.

At the instigation of the B.D.A. Sub-Committee in Dental Research, the incidence of caries-free dentitions in recruits joining all three services has been studied since 1957. The interim results, related to certain factors widely believed to influence decay, were the subject of a Combined Services demonstration at the 1961 British Dental Association Conference in Harrogate.

Recruits to the Navy, Army and Air Force are dentally examined as a routine joining procedure. In addition, for a period of about three years, all those who presented neither extractions, fillings nor decay were picked out for closer observation. Subsequently they were brought back and subjected to searching clinical and radiological tests. At this stage many failed to maintain their integrity and were rejected. The remainder were documented in terms of place of birth and upbringing, familial characteristics, diet, habits, oral hygiene and so on, whilst their dental status was recorded with study models and radiographs. These numbered only 181 out of over 90,000 examinations, a ratio of about 1/500.

Certain data were obviously insignificant from the outset. Places of birth and upbringing were so far flung as to make any kind of correlation impossible. To a notable extent these were the children of Service families. They were born in the five continents of the world, and had spent their childhood in widely separated environments. They went to school in Trinidad, Aldershot, Hong Kong, Aden, Malta, Cyprus, Singapore and Blackpool; the geographical factor had to be excluded from the calculations.

Similarly it was necessary to abandon hereditary considerations. Human lives are too long and human memories too short to permit the genetic pattern to be

apparent in any except the most exalted families. Moreover, the [illegible] having no dental troubles of their own, exhibited lack of interest in the [illegible] conditions affecting the rest of their families which, had they been [illegible] would have provoked indignation in parents and siblings alike.

They were on firmer ground when it came to smoking, diet and eating sweets, though these were not without their pitfalls. One rating in H.M.S. *Ark Royal* said he never ate sweets at all, a fact that was duly recorded with some approval. Later, under interrogation, he admitted to eating chocolate to the extent of a pound and a half a day.

The assessment of some of the chosen factors, such as the standard of oral hygiene, were subject to the individual opinion of the examining officers. Some anatomical characteristics, for instance, could be judged from the study models. But others, such as habits and diet, were dependent on the testimony of the men themselves. There is no reason to suppose that it was untrustworthy. Ordinary mortals may lie to the dentist to avert his wrath, but these people were immaculate. Whatever it was that it took, they had got. They could afford to tell the truth and shame the Devil.

A summary of the results is reproduced below. In Harrogate, where it was represented by a bar-chart, some consternation was caused among certain of the delegates. The chosen factors were reduced to twelve, and their prevalence was expressed as a percentage of the caries-free group to be affected by them. Thus 66 per cent were smokers and 19 per cent showed evidence of attrition.

Percentage incidence of twelve chosen factors in 181 caries-free individuals

Smokers	66 per cent
Sweet Eaters	94 per cent
Raw Fruit and Vegetable Eaters	64 per cent
Good Oral Hygiene	69 per cent
Tartar Present	49 per cent
Teeth Brushed Daily	71 per cent
Teeth Never Brushed	2 per cent
Anterior Crowding	31 per cent
Wide Arches	39 per cent
Imperfect Occlusion	66 per cent
Attrition	19 per cent
High Cusps and Deep Fissures	85 per cent

The age limits of the group were 15–24 years, comprizing 0.2 per cent of the total examinations.

In the absence of control data no attempt was made to explain the findings, but none of the chosen factors would seem to be of overwhelming significance.

Follow-up data available so far indicate that the resistance is relative and not absolute. It is liable to break down in later life. This will be some consolation to those of us who may feel that in a world where everybody got his deserts it should not have been possible thus to have flouted the principles of dental health education with impunity.

ACKNOWLEDGMENT

Our thanks are due to the Editor of the *R. C. Dental Corps Quarterly* for permission to reproduce this article.

Clinical Notes and Cases

PROBLEMS ENCOUNTERED IN THE TREATMENT OF A SUCCESSION OF CASES OF DECOMPRESSION SICKNESS

By Surgeon Lieutenant G. WRAY, R.N.

Introduction

THE purpose of this article is to give an account of the problems encountered during the treatment of a succession of cases of Decompression Sickness and to discuss the similarity with a possible situation following a successful escape from a sunken submarine. It is suggested that the facilities provided for the recompression of survivors may bear appraisal.

The diving procedures that produced the following cases of "bends" were purely experimental and were known to be potentially hazardous, i.e. the safety margins were less than in normal diving decompression practice. The cases occurred and were treated in H.M.S. *Reclaim* during one phase of an extended trial designed to test and compare Royal Navy and a modified U.S. Navy decompression schedules.

Note on the Recompression Chamber employed

The main recompression chamber fitted in H.M.S. *Reclaim* is a three-compartment type. The larger central compartment is flanked by two smaller "air lock" spaces and the whole arrangement is sited thwartships, hence these two latter spaces are referred to as "port" and "starboard". The doors, four in number, all hinge inwards and seal by means of an interrupted thread. When pressure is applied to a compartment the doors thus become more firmly seated, but this also means that should the pressure in the side spaces exceed that in the centre, inward leakage will occur as the doors are lifted from their seatings. This was the basis of the practical difficulties that were encountered.

Narrative

On 25th November, 1960, Diver A dived to 120 feet for 75 minutes and was decompressed in the water on a Modified U.S.N. Table. His gauge depth reading had varied between 122–123 feet. He surfaced at 1110. At about 1200 he complained of feeling generally unwell and at 1300 had aching in all limbs. He was pale and in a mild state of shock. Recompression was started at 1341 and symptoms were relieved at a simulated depth of 22 feet. The central ("main") compartment was taken to 100 feet and decompression on Therapeutic Table I instituted, timed to end at 2041. Diver A was accompanied by Attendant X.

Meanwhile, routine diving proceeded and eight dives were performed that day. Diver B had also been to 120 feet for 75 minutes with the same decompression as Diver A and his depth readings were all 123 feet. Diver B surfaced at 1231 and by 1300 he complained of an ache in the left knee (the same site as a previous bend on 5.7.60) which was partially relieved by a hot bath and Aspirin gr. 10. However, by 1400 the pain was worse and he required recompression. At this time Diver A had reached his 20-feet stop and with his Attendant X was transferred to the starboard

lock at that depth Diver B and Attendant Y then entered the main compartment via the port lock, and the pressure was raised until the pain abated at 100 feet Recompression was continued down to a depth of 165 feet and a Therapeutic Table 2 decompression started due to end at 0032 the following day Thus the situation at 1500 was such that Diver A was inaccessible in the starboard lock, this being taken as a calculated risk

Diver C had spent 75 minutes at 120 feet and was decompressed on the R N Table He surfaced at 1603 and soon afterwards experienced aching in the left elbow and both legs A hot bath and Tab Codein Co produced little improvement He had been working particularly hard on the bottom At 2000 during a wardroom cocktail party after two gins he felt and looked generally unwell Aching had extended to both shoulders hips across the abdomen and down the right leg He was pale with a dry skin, the pulse remaining 65 per minute regular with good volume It was decided, unwisely as it subsequently transpired, to wait outside the recompression chamber until Diver A had completed his decompression at 2041 At 2025 when reclining in a low chair Diver C lost consciousness the pulse was as before He was hastily placed in the empty port lock attended by the Medical Officer and Attendant Z Pressure was increased from Atmosphere to 20 feet and an exchange of occupants with the main compartment performed at that depth before carrying on down to 165 feet. During the transfer Diver C began to recover consciousness and after a few minutes at that depth he was symptom-free At no time had cursory examination of the C N S revealed abnormal signs

Thus at 2040 the situation was that the starboard lock contained Diver A and Attendant X surfacing at 2041 from 10 feet The main compartment contained Diver C attended by the Medical Officer and Attendant Z at the start of a Therapeutic Table 3 decompression from 165 feet due to surface at 1621 the next day The port lock had Diver B and Attendant Y at 20 feet, due to surface at 0032 the next day

Following the surfacing of the starboard lock the Medical Officer was transferred to that space and decompressed on the appropriate Diving Table He was greeted by Diver A who complained of some stiffness and a slight ache in the left knee but this was regarded as being the result of confinement in a cramped space for 7 hours and he was despatched to his bed with Tab Codein Co

All went well until 0032 on the second day, when the port lock was surfaced Upon opening the exterior door Diver B suffered the sudden recurrence of severe pain in the same site (left knee) with radiation up the thigh Pressure was quickly re applied to the port lock still with Attendant Y It was taken to 30 feet when the pain became bearable The door to the main compartment was opened (by this time Diver C s decompression had reached this depth) and a pause made for some rapid thought It was decided to remove Attendant Y (for " humane " reasons) and allow Attendant Z to attend Divers B and C in the main compartment as the starboard lock was too small for two men for at least 16 hours and without access from the outside This meant that Diver C would be subjected to a second and unnecessary recompression for the benefit of Diver B but the alternative was the risk of having a patient with a Cerebral bend (Diver C) in an inaccessible space Therefore Atten

dant Y remained in the port lock and was raised to 10 feet for 5 minutes and then decompression for his second dive

The last problem arose when the main compartment with its three occupants descended for Diver B's second recompression The Attendant Z started to get pain over his frontal sinus which was not relieved by vigorous nose-blowing and the recompression was stopped When Attendant Y had vacated the port lock, Attendant Z was transferred at about 40 feet and recompression in the main compartment resumed with Divers B and C attending each other

The main compartment was taken to 100 feet when Diver B reported that he had only a slight ache below the left patella On reaching 165 feet he was symptom free A Therapeutic Table 3 decompression was started timed to end at 2042 on 26th November During the second recompression Diver C subsequently reported that an ache in the right shoulder recurred mildly and many of his joints clicked

Meantime Attendant Z in the port lock had been relieved of his sinus pain by being raised from 40 feet to 30 feet but he required some form of decompression routine for his time spent as an attendant in the main compartment On purely empirical grounds (1) he was given 2½ hours at 20 feet and 2½ hours at 10 feet before surfacing luckily without sequelae

Eventually at 2042, the main compartment was opened at surface pressure Diver C had some residual aching in his right shoulder but since it had been unaffected by subsequent pressure changes this was treated symptomatically Within 24 hours none of the patients had any complaint and physical examinations were within normal limits

H M S *Reclaim* is fitted with another recompression chamber and this was held in readiness after the second bend occurred (Diver B) but was not employed due to Diver C's collapse and possible waste of time in manning the controls There were at that time other practical difficulties in the use of this second chamber

Discussion

The similarity between the described episode and a possible situation following a successful submarine escape by free ascent method merits discussion The two techniques taught in the Royal Navy for leaving a sunken submarine are (1) Compartment Escape and (2) Tower Escape The former entails the simultaneous exposure of a relatively large number of individuals to increased partial pressures of Nitrogen for varying periods because they escape in succession The latter method involves the exposure of pairs of escapers for short periods of increased pressure before leaving the submarine Compartment Escape is therefore much more likely to yield cases of decompression sickness depending on depth number of escapers and rate of compartment flooding Both methods are as likely as each other to produce cases of Air Embolism but this condition is relatively rare and will never be a major problem of numbers whereas decompression sickness of the Nitrogen Bubble variety (as in the Narrative) may well tax the recompression resources Thus on the surface the arrival of a succession of survivors who develop signs and symptoms of decompression sickness the Officer in Charge who may or may not be advised by a Medical Officer is likely to be faced with a situation resembling that described

The policy to be adopted in respect of recompression of survivors will depend upon

many factors, not least being the advice given by any Medical Officer available. The recompression facilities (number and type of chamber(s) and availability of submarine compartments for this purpose) and expected incidence of decompression sickness should be considered at an early stage in the escape. Where large numbers are likely to be affected, sorting into priorities for recompression will be necessary. This may be based upon the incidence amongst early escapers (in compartment escape) as the later ones are more likely to be affected. Cases of Air Embolism, Spinal or Cerebral Bends will require rapid life saving recompression. Subsequent cases will have to be "locked" into the main compartment, when this facility is available, to be held at high pressure for long periods to benefit the worst cases. When chamber space is at a premium it may be necessary to treat pain cases symptomatically with analgesics although this may be a difficult decision as Medical Officers with experience of them will know. When this policy is adopted, careful observation is imperative as a state of shock may ensue requiring immediate recompression. Where practicable, Helicopter evacuation at low altitude to shore chambers should be employed and reserved for those pain cases who have not received recompression.

When only a few cases occur and all expected survivors have escaped, it may be advisable to recompress them all prophylactically. In this situation a compartment of a submarine is ideal.

The Medical Officer will have to decide where he is best employed. If he is the only doctor present, the instinct to go into the chamber with early serious cases must be resisted. It is possible to treat them over a telephone and observation through a port, largely based upon the relief of symptoms rather than the elicitation and suppression of physical signs. In this manner the Medical Officer is available to advise the Executive branch more readily and to deal with other problems.

It is understood that the design and construction of a light weight recompression chamber in which it is possible to have pressure tight doors with a differential from either side, is a major problem and hardly practicable. However, if this were achieved the versatility of the chambers would be somewhat increased.

Summary

An episode in the treatment of a succession of cases of decompression sickness is described and is related to possible decompression problems after submarine escape. A lesson may be learnt from the confusion that ensued in what was ostensibly a very adequate recompression chamber. The advice given to officers in charge of surface arrangements for submarine escapers is reaffirmed for the benefit of Medical Officers, any of whom may be involved.

Recompression chambers provided for use in SUBSUNK should be the lightest type available and provide facilities for the insertion or removal of patients from a main compartment, i.e. at least two compartments. This is the minimal acceptable quality.

ACKNOWLEDGMENT

I must acknowledge the staunch support of Chief Petty Officer W. B. Powis (ex Chief Diver H.M.S. *Reclaim*) during the treatment of the cases, and my thanks to Surgeon Lieutenant-Commander D. E. Mackay, R.N., for his helpful advice and comments in the preparation of this article.

AN INTERESTING CASE HISTORY OF LATENT DIABETES AND TUBERCULOUS CERVICAL GLANDS

By Surgeon Lieutenant J S POVEY, R N

T T R S A (1) *Single* *Aged* 23 This rating reported to the sick bay at H M S *Sea Eagle* on 31st July 1961, complaining of a swelling in the right side of his neck, present for two weeks with no pain discharge or sudden increase in size He had no other complaints A similar smaller swelling had appeared three months previously associated with a sore throat but this had subsided without treatment

No swelling elsewhere
Appetite good
Weight steady
No cough or sputum
No micturition symptoms

Past History	Normally very fit Appendectomy Left inguinal herniorrhaphy
Family History	No family diseases
Social History	Smokes 10 cigarettes per day
On Examination	Fit young man T P R normal Soft fluctuant swelling situated along the anterior edge of the trapezius in the right posterior triangle 2" × 1 appeared to be attached deeply Right tonsillar gland enlarged No other glands palpable *Throat* clear *Chest* clear *Abdomen* liver and spleen not felt

He was admitted to the Military Hospital Waringfield Moira Co Down under Captain Pollock R A M C Surgical Specialist

Investigations

Hb 105% W B C 4 400/cm
Differential normal No abnormal cells seen
E S R 3 mm/hour (Westergren)
Heaf positive III
Sputum x6 No A A F B
Urine *Sugar* present in all specimens
Chest X-ray N A D
Fasting blood sugar 125 mg/100ml

... *lerance curve* as follows

Specimen	Glycosuria	Ketonuria	Blood Sugar
Fasting	,	Nil	125 mgm
½ hour		Nil	145 mgm
1 hour		Nil	200 mgm
1½ hours		Nil	130 mgm
2 hours		Nil	120 mgm
2½ hours		Nil	115 mgm

A presumptive diagnosis of caseating tuberculous glands of neck with abscess formation in a patient who is a mild diabetic was made

13 8 61 Chemotherapy commenced —
Streptomycin 1 gm daily
Isoniazid 0 1 gm b d
P A S 5 gm b d
A diabetic diet was instituted

15 8 61 *Operation*
Watery pus was evacuated from the cold abscess in his neck and a quantity of curettings were obtained Many deep glands were involved 1 gm of Streptomycin was injected into the cavity
Pus Direct film No A A F B seen
Culture negative
Curettings Typical tuberculous granulation tissue
No A A F B seen

29 8 61 His diabetic state was found to be uncontrolled on a diet alone and insulin therapy was commenced increasing to 24 units IZS Lente with a 2 800 calorie diet On this regime his weight remained constant (144 lbs) he appeared satisfied with his calorie intake and glycosuria was well controlled It was advised that he continued Streptomycin until 90 gms had been given and to continue P A S and I N A H for a further 12–15 months after this

The incision in his neck healed well after further aspiration

10 10 61 Discharged to R N Hospital, Haslar for review

Comment

This is a case of latent diabetes almost certainly exacerbated by Koch's infection of the cervical glands It stresses the importance of routine urine testing on all admissions to hospital or sick bay during Fulteems examinations and where other wise indicated Testing for sugar is made easy by the modern "quick" methods

The presence of tuberculous cervical glands is interesting as the condition is seen chiefly in children and about 70 per cent of infections are due to Bovine types of bacillus A similar case is being investigated at present and may stimulate further comment on these points

In the present case it is likely that with the elimination of the tuberculous focus insulin may be withdrawn at a later date and stability continued with a diet alone

Reviews

[illegible] Michael Gelfand [illegible] D.P.H. D.M.R. [illegible] photographs. London [illegible] E. & S. Livingstone [illegible]

[illegible]

[illegible] background of the [illegible] diagrams of life cycles [illegible] photographs and X-ray plates [illegible]

Chapter [illegible] The Concept of African [illegible] The Reaction on [illegible]

[illegible] brought into the medical [illegible] of this great continent [illegible] of suffering [illegible] appropriate [illegible] however enthusiastic [illegible] help from outside [illegible] the good fortune to practise medicine in Africa [illegible] the sound [illegible] Thereafter [illegible] constant source [illegible]

S. M.

[illegible] By Sir Stanley Davidson B.A.(Camb.) [illegible] F.R.S.(Edin.) Fifth Edition [illegible] E. & S. Livingstone Ltd. Price 35s. [illegible] 2s. 6d. postage.

[illegible] a tribute to its author and the value of [illegible]

[illegible] 45 pages [illegible] new material added [illegible] subject matter has been presented [illegible] experts in their particular field and reflect a [illegible] to the reader. Perhaps one might say that [illegible] otherwise the book would lose that appeal [illegible]

[illegible] readily available the most up to date knowledge [illegible] student and experienced physician will find it [illegible] should be without it.

I. C. M.

[illegible] By John Charnley B.Sc. M.B. F.R.C.S. [illegible] photographs and illustrations. London and Edinburgh: E. & S. Livingstone Ltd. Price [illegible] Postage 1s. 3d.

[illegible] primarily for the Country Surgeon but [illegible] any valuable lessons for us all.

[illegible] techniques, the presentation and the [illegible] quality [illegible] themselves.

[illegible] dismissed [illegible] fractures [illegible] the femoral neck as [illegible]

[illegible] shaft and upper humerus [illegible] having decided [illegible] of the long bones [illegible]

However [illegible] clearly [illegible] we must [illegible] and the harmful effects [illegible]

If any parts are to be [illegible] for special [illegible] of fractures about the ankle and their plastering. This is [illegible] yet not unusual [illegible] and not one that is always [illegible] teaching.

To sum up [illegible] the book [illegible] K. J. H.

The Practical Management of Head Injuries. By John M. [illegible], M.A., M.B., B.Chir. (Cantab.), F.R.C.S. Pp. xi + 84 and [illegible] illustrations. London: Lloyd-Luke (Medical Books) Ltd. Price 12s.

This is a pocket-sized book which is intended [illegible] of guidance to all young House Officers and those others who only infrequently have to manage patients suffering from head injury.

The book is set out simply. There is a wide margin in which the salient points of the text are noted: this is helpful in emphasizing special points.

The illustrations are line drawings which clearly show the [illegible] of the various [illegible] sponses found in head injuries.

The information given is based on the author's extensive experience of head injuries and is sound. He avoids the rarer phenomena and keeps to broad outlines which cover the majority of cases.

The section on rehabilitation is of interest but in the special environment of the Naval Service all his comments do not hold good.

The book would at first sight appear expensive at 12s., however this is a small price to pay for insight into the [illegible] of severe head injuries. F. R. W.

Aerospace Medicine. Edited by Major General Harry G. Armstrong, U.S.A.F. (Retired). Pp. xiv + 633. Many diagrams, drawings and photographs. London: Baillière, Tindall & Cox Ltd. Price £7 4s. 0d.

For many years Armstrong's "Principles and Practice of Aviation Medicine" has been one of the very few comprehensive books in the English language dealing with this subject. The volume under review is not only a replacement for the older, but its scope has been widened as indicated by the title. The text has been re-written rather than revised, and Armstrong himself is not now the sole author.

Some of the contributors' chapters are not, perhaps, as clearly expressed as would be wished: that entitled "Psychological Methods of Aircrew Selection", for example, requires previous knowledge of the American approach to this matter, and "Effects of Atomic Energy" is marred by a confusing number of technical definitions and abbreviations.

In general, however, this is a satisfactory source book of information and guidance on the majority of those aspects of aviation which the Naval Medical Officer is likely to encounter. Detailed applications as affecting British apparatus must naturally be sought elsewhere. It is unfortunate that references to British work are so scanty, among these is Rawlins's work on underwater ejection which is allotted a third of a page.

The main disadvantage to the intending purchaser, however, is the price, for this one might wish to receive more information on space flight than is given in the eighteen pages devoted to this half of the book's title. J. K.

Drugs in the Treatment of Disease. From the *British Medical Journal*. Pp. x + 516. London: British Medical Association. Price 35s.

We are today in the midst of a welter of medical preparations produced in ever greater profusion by drug houses for whom business is booming as never before. The name on the bottle didn't matter much in the old days. Nothing much was expected either way. Today any preparation we turn to might elicit the most salutory results in our patient—or poison him. Nor can we shirk the issue, but must go fearfully forward through the jungle in search of something of value. No better key to the nomenclature could be imagined than that provided in this *B.M.J.* publication.

In the words of the [illegible] this book is intended to give practical guidance on the use of the old and new drugs. The authors of the various chapters, which originally appeared as *B.M.J.* articles, compare the efficacy of different drugs, give recommendations on dosage and discuss toxic effects. The names of more than sixty contributors, selected specialists in their own field, read like a contemporary hall of fame. The book is divided into thirteen sections covering the systems and counting sedatives (in the broadest sense), rheumatism and infections disease separately. The final section is a miscellany embracing special problems of pediatrics and geriatrics and the widening menace of addiction and poisoning.

Of course one enjoys some chapters better than others (this really depends on one's own style), but it is all professional, authoritative writing, with an eye to getting the facts across without restless verbiage. It is really remarkable how such a book, which in its scope would stand comparison with any recent publication on therapy, could have been produced in a size compatible with the average overcoat pocket. Naturally it is already behind on steroids, antibiotics and the recent spate of anti-depressives. Is this altogether a bad thing? If you care about such things you must have this book. It is most emphatically a best buy! W. E. W.

[illegible] TO HUMAN PARASITOLOGY FOR MEDICAL PRACTITIONERS [illegible] Fresh and Southwell. Revised by T. H. Davey, O.B.E., M.D., D.T.M. Seventh Edition [illegible] 225. Three coloured plates and 119 text figures. London: H. K. Lewis Ltd. Price [illegible]

This seventh edition of a textbook which has held its place [illegible] valuable guide in human parasitology since 1931 has needed relatively little revision. That [illegible] experienced workers as Professor Davey should have found so little alteration necessary is [illegible] indication of its soundness and great value. The reviewer has himself used this book consistently for the past 20 years and has no hesitation in recommending this new edition to all who have [illegible] to learn human parasitology. It is simple in its presentation, [illegible] arranged, compact, [illegible] material and contains at its final pages a series of illustrations of the life histories of [illegible] which are abundantly clear and easy to follow. The few changes introduced by the reviser which have been necessitated by recent advances in knowledge ensure that the present volume is up to date and minor readjustments in presentation have ensured that there has been no [illegible] in bulk. At 30s. this book is indeed good value for the money.

S. M.

We acknowledge with thanks receipt of the following publications

Acta medica et Biologica. Annals of Tropical Medicine and Parasitology. British Medical Journal. Bulletin of the World Health Organization. Guy's Hospital Gazette. Journal of the Royal Army Medical Corps. Kanazawa Journal of Medical Science. Le Medecin de Reserve. Mid. Medical Journal. Medical Digest. Middlesex Hospital Journal. Military Medicine. Montreal Medical. Nagoya Journal of Medical Science. Proceedings of the Staff Meetings of the Mayo Clinic. Revista Medica. Revista De Instituto De Medicina Tropical De Sao Paulo. Revista Medica del Hospital Colonia. Sanitatsofficierblatt. [illegible] St. Mary's Hospital Gazette. The Australian Journal of Experimental Biology and Medical Science. The Australian and New Zealand Journal of Surgery. The Bulletin of Tokyo Medical and Dental University. The Journal of the Irish Medical Association. The Kumamoto Medical Journal. The Manchester Medical Gazette. The Medical Press. The Tohoku Journal of Experimental Medicine. Tropical Diseases Bulletin. Vestnik dermatologii i venerologii.

News of the Service

OBITUARY

Surgeon Commander F J L P McKENNA R N (Retired) died on the 26th November 1961 aged 90 years

Surgeon Commander McKenna qualified as M R C S and entered the Royal Navy Medical Service on 8th November 1898 as a Surgeon He was promoted to Staff Surgeon on 8th November 1906 and to Surgeon Commander on 8th November 1914 He was placed on the Retired List (Own request) on 3rd June 1921

Surgeon Captain Campbell ROSS died on the 30th October 1961 He was born on 3rd June 1881

Surgeon Captain Ross qualified as M B M O D P H He entered the Royal Navy Medical Service on 14th May 1907 as a Surgeon Lieutenant He was promoted to Surgeon Lieutenant Commander on 14th May 1915 and to Surgeon Commander on 14th May 1919 He was placed on the Retired List (Age) with the rank of Surgeon Captain on 3rd June 1931

Surgeon Captain Ross rejoined on the 4th September 1939 as Surgeon Commander at *Afrikander I* for Simonstown Dockyard and was released on the 1st June 1946 in South Africa.

HONOURS AND AWARDS

Companions of the Most Honourable Order of the Bath

Surgeon Rear Admiral W V Beach *O B E* Q H S F R C S (Edin)
Surgeon Rear Admiral (D) W Holgate *O B E* Q H D S L D S

Commander of the Order of the British Empire

Surgeon Captain F W Baskerville L M S S A

Officer of the Order of the British Empire

Surgeon Commander R F Phillips M B D S., D O

Appointed Queen's Honorary Surgeons

Surgeon Captain H L Cleave *O B E* F R C S
Surgeon Captain W J F Guild M O F R C S (Edin.)

PROMOTIONS

To Surgeon Lieutenant-Commander—D D McCarthy M B B Ch
To Surgeon Lieutenant Commander (D)—G S Taylor

Provisional selections for promotion to date 30th June 1962

To Surgeon Captain—F H Lamb M R C S L R C P R M Goldsworthy M B B S M R C S L R C P D M R D B Ridgeway M B Ch B D M R D R W Duncan M B Ch B
To Surgeon Commander—J A B Harrison M R C S L R C P D M R D F J O Kelly M B B Ch D P H W R Wilden L R C P & S C W J Usher M R C S L R C P

TRANSFER TO THE PERMANENT LIST

Surgeon Lieutenant D E Day M B B S M R C S L R C P D A

RE-ENTRY

Surgeon Lieutenant K J Martin M D B Ch

RETIREMENTS

Surgeon Captain J L S Coulter *D S C* F R C S L R C P Barrister at Law (Own request)
Surgeon Captain W J M Sadler *C B E* Q H S M R C S L R C P (Age)
Surgeon Captain J H Nicholson Q H P M B Ch B D P H (Age)
Surgeon Commander A W W Robinson M D L R C P L R C S D P H D I H (Own request)
Surgeon Lieutenant Commander W R Wright M B Ch B M R C P (Edin) (Invalided)
Surgeon Lieutenant (D) J P Wills B D S L D S R C S (Invalided)

RELEASED ON COMPLETION OF SHORT SERVICE

Surgeon Lieutenants W I Millar M B B S D R C O G C L Kelly M B B S J C McKe[illegible] M B B Ch
Surgeon Lieutenants (D) D J Davison L D S and H K Kemp B D S L D S

WARDMASTER OFFICERS

Wardmaster Sub-Lieutenant W L Harrington (Invalided)

QUEEN ALEXANDRA'S ROYAL NAVAL NURSING SERVICE

HONOURS AND AWARDS

ROYAL RED CROSS

Associates Second Class

Miss Sheila Houston Superintending Sister
Miss Enid Roberts Head Naval Nursing Auxiliary

PROMOTIONS

To Matron—Miss N H Giles A R R C

RETIREMENT

Miss O M Molyneaux R R C Superintending Sister/Matron

ROYAL NAVAL RESERVE

PROMOTIONS

To Surgeon Commander—F Millyard
To Surgeon Lieutenant Commander—R W Bentley A J Bowdler E S Blackadder D Churchill Davidson R M Foster J A Meade J Vernon Parry
To Surgeon Lieutenant-Commander (D)—J F Farrell and C G Buchan

RETIREMENT

Surgeon Captain (D) A C Fuller V R D L D S R C S

No 2 Spring 1962 Vol XLVIII

Journal

of the

Royal Naval Medical Service

PUBLISHED QUARTERLY

(The Admiralty does not accept responsibility for the opinions expressed in this Journal)

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EDITED BY

THE STAFF OF THE ROYAL NAVAL MEDICAL SCHOOL
ALVERSTOKE HAMPSHIRE

Editorial

A SYMPOSIUM on Current Underwater and Aviation Medical Problems was organized jointly by the Royal Naval Medical School and the Royal Naval Air Medical School and held on Wednesday 29th and Thursday 30th November in the latter establishment. The Symposium was well attended by Medical Officers from many Air Stations and local establishments and the lecture room was full for all sessions. In addition, representatives of the American Navy and Executive Officers were present.

We have reproduced in this issue of the JOURNAL selected papers presented at the Symposium and all were followed by a stimulating discussion. A most excellent paper by Surgeon Lieutenant Antony Jarrett, M.Sc., M.B., R.N., has been omitted from the series because of its publication elsewhere, i.e. *British Medical Journal*, 19th August, 1961, p. 483, and in part in the *Journal of the Royal Naval Medical Service*, Vol. 47, p. 13. Film demonstrations and talks on Life Raft Trials by Surgeon Captain J. W. Baskerville, *C.B.E.*, R.N., and a Pressure Breathing Demonstration by Surgeon Lieutenant M. Hatfield, M.B., B.S., R.N., were also presented.

The undoubted success of this type of meeting (a similar type of meeting being held in the previous year) indicates the popularity of this means of bringing together experts in various medical fields and it is hoped that in the future more of these symposia may be arranged for the different specialities.

In order to present the papers of the Symposium in one issue of the JOURNAL without exceeding economic limitation in size, Part VI of Surgeon Commander J. Glass's paper on "A Concise Treatise on Marine Science" has been withheld until the next issue when this and the final part will be published together. This is an appropriate adjustment as the next issue of the JOURNAL will contain an exceptionally fine article on "The Aetiology, Clinical Pathology and Treatment of Shark Attack" by Professor David H. Davies, M.Sc., Ph.D., and Doctor G. D. Campbell, M.B., M.R.C.P.(Edin.), Director and Research Associate respectively, Oceanographic Research Institute, Durban, South Africa.

THE ROYAL NAVAL MEDICAL SCHOOL celebrated its Fiftieth Anniversary on the 1st May this year. On this day in 1912 it was opened at Greenwich College by Admiral Prince Louis of Battenberg, then First Sea Lord. It was responsible for the instruction of Medical Officers in three groups—(1) New Entry Surgeons, (2) Surgeons of between four and six years seniority who were given a refresher course in Naval Hygiene and Clinical Pathology to prepare them for examination for Staff Surgeon, and (3) Medical Officers of 14 years or more seniority who were given a further refresher course of three months duration.

These courses were arranged in conjunction with a London teaching hospital and did much to correlate post graduate instruction in the Naval Medical Service.

Courses stopped during the First World War and the staff was reduced to a minimum requirement to continue with bacteriological and chemical examination of water and air supplies and routine pathology. In 1916 T.A.B. vaccine for Naval

use was produced After the War much of the training of Medical Officers was carried out at the Royal Hospital Haslar Promotion Courses to Surgeon Commander however, were continued under the control and direction of the Medical School These courses were of four months duration and were followed by an examination on the result of which the award of the Gilbert Blane Medal and accelerated promotion could be given After evacuation to an old house in Somerset during the Second World War the School came to its present home in Monckton House in June, 1948

Today, in spite of the difficulties through which the Medical Branch is passing, the School is maintaining a fairly active existence concentrating largely on the teaching of radiation medical problems underwater physiology, and some hygiene and tropical medicine A growing programme of research is planned and its position in the Naval Medical Service today is well established Courses in Radiological Defence are attended by members of other Services N A T O Forces and civilian organizations

Papers

read at the Joint Symposium by Royal Naval Medical School and Royal Naval Air Medical School on Current Underwater and Aviation Medical Problems on Wednesday 29th and Thursday 30th November, 1961

TRIALS OF UNDERWATER BLAST FROM MARTIN-BAKER TYPE 4 EJECTION SEAT GUN—JUNE, 1961

By Surgeon Commander J S P RAWLINS, R N

Introduction

DURING earlier trials of ejection seats for underwater escape from ditched aircraft pressure/time records were obtained for the blast waves transmitted to the water by various Martin Baker ejection guns From these were calculated the impulse and energy of the pressure waves

It has been suggested that the maximum pressure of the blast wave may not be as significant in terms of human tolerance as are the impulse and energy parameters of the pressure waves and since the energy of the wave front produced by discharge of the Type 4 and 5A Martin-Baker guns (70 ft lb/ft^2 at 8 ins) is considerably larger than that produced by the Type 1 gun (52 3 ft lb/ft^2 at 9 ins) which was the worst gun from this aspect tested hitherto by human subjects, it was thought desirable to carry out animal experiments to confirm that the introduction of more powerful types of gun would not seriously prejudice the chances of successful underwater escape A recommendation to this effect was made in the report of the trials

Recently the situation has been further complicated by the introduction of high energy cartridges which are essential for airborne escape during high speed low-level flight in the Blackburn Buccaneer It is to be expected that these cartridges will produce a pressure wave of greater energy than that from the older cartridges and therefore, since underwater ejection is recommended as the best method of escape from the Buccaneer should the aircraft submerge with the canopy in position it is important to establish the safety of the combination of Type 4 gun and new cartridges for underwater escape before the aircraft enters the Service

Trials Programme

During the previous trial subjects exposed to the Type 1 gun blast experienced localized pains in the chest which persisted for some hours There was no means of diagnosing the origin of these symptoms which could have resulted from trauma to the chest wall diaphragm or lungs

Previous work on injuries from underwater blast related solely to the detonation of high explosive and from this two broad types of injury may be distinguished The first is rupture of gas-containing hollow viscera such as the lungs and intestines

and results principally from the shock wave, a pressure pulse which [illegible] rise time of the order of 1 microsecond and a time constant of the order of 1 millisecond and moves outwards at approximately 5 000 ft/sec. The second type of injury involves solid tissue such as the liver, muscle and even bone, and results principally from shear forces set up by the ram effect of the water which is set in motion by the shock wave. The velocity of this water flow is of the order of 15–30 ft/sec and is proportional to the shock-wave pressure.

In the case of the ejection gun, however, the records obtained so far had failed to reveal any shock-wave comparable to that arising from the underwater detonation of high explosive so that the previous findings with regard to injury could not be applied. But it was possible that this was due to the mensuration techniques employed for both the transducers and recorders had a relatively low frequency response and would not have responded to such a high speed phenomenon.

Discussions were accordingly held with N.C.R.E. on the validity of the results obtained in the previous trials and although it was agreed that since the explosive system in the ejection gun consisted of a series of cartridges designed to give a slow build-up of pressure rather than an instantaneous detonation yet the pressure pulse transmitted by the excess gases at the moment of separation might be similar to that from a high explosive detonation and in order to determine this point it was necessary to use crystal gauges with a very high-frequency response, photographing the records on oscilloscopes.

The first requirement of the trial, therefore, was to check the validity of the previous trials and to establish beyond doubt the physical parameters of this unusual type of underwater phenomenon.

The next requirement was to determine the pattern of injury and if possible to relate it to the physical data and to the symptoms produced in human subjects.

Clearly it was insufficient merely to place an animal in a Mk. IV seat, eject the seat underwater and perform a pathological investigation. In the first place, owing to the superior resistance to trauma of most animals it might prove impossible to demonstrate any clearly recognizable lesion pathologically. In the second place, if a lesion were demonstrated it might be impossible to decide whether it should be attributed to the blast or to one of the other conditions (acceleration, drag) of the ejection. Therefore it was decided to eject the seat with an anthropomorphic dummy (to attain the correct drag profile) up a ramp and to mount the experimental subject on the opposite side of the ramp in an appropriate position relative to the separation point of the gun. In this way human and animal subjects could be exposed to the blast at various distances from the separation point and with varying amounts of shielding between them and the gun without subjecting them to the drag and acceleration of the moving seat.

To overcome the difficulty of minimal injury the first animals would be exposed as close as possible to the separation point (9 ins.) without any protection from the blast other than was afforded by a skeleton frame of brass tube and webbing. In this position the animal's back was towards the gun and its diaphragm roughly opposite the separation point. This was termed the "worst" position and would be used to determine the maximum injury (if any).

Next animals would be exposed in the same frame but in the same position relative to separation point as would be a man in the moving seat at the moment of separation These should demonstrate the attenuation of injury due to the relative displacement away from the separation point

Next the shielding effect of the seat pan would be investigated and if it were then possible to decide the pattern of injury, its attenuation first by distance and then by shielding and to demonstrate that the combination of these last would result in minimal injury human exposures in the static seat would be carried out

Finally if all results so far were satisfactory live ejections in the moving seat would be made

Progress of the Trials

Physical Data

After some initial difficulty satisfactory recordings of the blast parameters were obtained together with records of seat velocity seat acceleration and gun pressure

Analysis of the records is not complete but in general all results were comparable with those obtained in the previous trials There is no high frequency shock-wave

Animal Experiments

The animals selected for the experiment were adult female sheep of approximately 100 lbs weight These were anaesthetized with Largactil and Nembutal and then a cuffed endotracheal tube was passed A special diving hood designed by the R N Physiological Laboratory and consisting of a neck seal, neck ring and rubber hood was then fitted and connected to a continuous-flow air supply from an S D D E panel Then as rapidly as possible the sheep was strapped into the handling frame picked up by a block and tackle and swung into position on the ramp where it was secured in position by two lugs and a quick release lock The whole rig was then submerged by lowering the floor of the tank, the sheep being attended underwater by two divers one of whom was in direct communication with the control position on the tank sill and with the camera position outside a window at the 20-ft mark Following the experiment the frame was released from the rig by the divers and carried to the surface where it was attached by a snap hook to a lifting gear and swung on to the tank sill

The animals exposed unprotected in the "worst" position suffered severe injuries In one there were lung hemorrhages and emphysematous bullae at the lung apices in the other there was a frank rupture of the liver along the attachment of the gall bladder The former injury is typical of that usually associated with water ram effect, this points to the dissimilarity between the ejection gun blast and that from underwater detonation of high explosive In the "normal" position unprotected one sheep showed minor lung injury and the other a minor rupture of the liver again adjacent to the gall bladder This specific attenuation of each type of injury in two separate animals must be regarded as a rather remarkable coincidence

The two animals exposed in the "worst" position but separated from the explosion by a sheet of ⅛-in hard aluminium showed no injury although the force of the explosion was such as to tear the aluminium sheet off the heads of the mounting bolts suggesting that these injuries were the product of some sort of water-ram effect which

is known to be effectively attenuated by interposition of a rigid metal structure.

(At this stage, due to lack of personnel, it was impossible to continue with the instrumentation, and high-speed photography having already been abandoned due to insurmountable technical difficulties, all subsequent experiments had to be carried out "blind".)

A mock-up seat pan was now constructed of $\frac{1}{4}$-in. light alloy plate (no spare Mk. IV pan being available) with a back of $\frac{1}{16}$-in. light alloy riveted to the main seat structure. This was considered by the Martin Baker representative to be comparable to the back of a Mk. IV pan as regards structural strength. This seat was then rigged in what was intended to be the "normal" position and a sheep exposed. Autopsy revealed minor lung damage and no damage to the liver.

After some discussion it was decided that it would be safe to carry out a human exposure in this position, taking into account that the anæsthetized sheep would be unprepared for the explosion whereas the conscious human subject would automatically tense his muscles and so increase the rigidity of the chest wall. The very much larger area of the chest wall, of course, might counter this effect to some extent.

The impression created by the test was one of considerable violence but it was by no means intolerable. Most of the rivets holding the $\frac{1}{16}$-in. alloy back sheared, tearing the right side away from the main structure. Symptoms attributable to some bruising of the lung and diaphragm were experienced but disappeared in a few hours. No after effects have been noticed.

It was then discovered that the seat, due to misunderstanding, had not been mounted in the correct position but some 11 ins. higher on the rig. After some discussion as to whether re-positioning in the correct "normal" position would significantly worsen the blast effect, it was decided to expose another sheep in this position. Autopsy revealed free blood in the abdomen, frank rupture of the liver adjacent to the gall bladder, massive hæmorrhages in both lungs, fluid exudate in the pericardium and bruising of the inner aspect of the chest wall. The $\frac{1}{16}$-in. alloy back was displaced as in the previous test and in addition there was some distortion of the main structure of the seat. In the circumstances it was decided not to proceed with further human exposures.

Discussion

The use of a rig up which to fire the seat was dictated not only by the necessity for exposing the subject to the gun blast independently of the drag and acceleration but also by previous experience of firing Mk. IV seats underwater; due to the drag on the seat pan there is a strong tendency to forward flexion which causes buckling of the seat pan and, more important, of the seat beams. The damage to the latter may be so severe as to render the seat unusable after a single shot. This same forward flexion also results in distortion of the inner tube of the gun which again may render it unusable after a single shot.

Owing to the scarcity of Mk. IV seats and Type 4 guns, therefore, it was decided to construct the experimental rig in such a way that the seat would be constrained during the greater part of its travel so that flexion damage would be positively avoided. This was achieved by using two 20-ft. vertical members of 6-in. U-channel light

alloy of 0.5 in thickness suitably buttressed and stayed to a 12 ft. square frame floor Within the channel ran brass rollers to which the seat was attached

This system worked satisfactorily in that the same two guns were used for the series of 16 tests and the same seat although in preventing forward flexion the strain of the seat pan was considerably increased so that it required to be massively re inforced and braced with wire stays Similarly the blast damage to the seat back was accentuated partly because in a free underwater firing the seat tends to move forward away from the gas bubble partly perhaps due to the confinement of the bubble laterally between the two vertical members, thus limiting its radial spread and consequent pressure reduction

With the mock up seat in the normal position the boxing-in of the bubble at separation was more extensive, being complete on the static seat side over a vertical distance of 2 ft 6 in complete laterally (by the U channel) over the whole distance of travel and more or less complete on the moving seat side over a vertical distance equivalent to the height of the seat back and drogue box Since the back panel of the mock-up seat was ⅛ in light alloy and only separated from the subject by the usual back pad and the back panel of the moving seat was considerably strengthened, the line of least resistance for the expanding gas bubble was in the direction of the subject's back and it is entirely possible that the effect of the bubble in these circumstances is greatly enhanced in relation to its effect in a free-water ejection

In view of the fact that the experimental situation is not fully representative only limited conclusions can be shown from the trial They are as follows

(1) The general appearance of the pressure pulses induced in the water by firing the Type 4 Martin-Baker gun with the high energy cartridges is in good agreement with that demonstrated by less sophisticated techniques in the previous trial, that is to say there is a maximum pressure of the order of 100 p s i at 8 ins from separation decaying roughly as the square of the distance
(2) The blast waves are potentially dangerous and are capable of causing severe injuries intermediate in pattern between those hitherto associated with the shock-wave from the underwater detonation of high-explosive and those associated with the water-ram effect.
(3) In the present state of knowledge it would be unjustified to carry out a human ejection test with this combination of gun and cartridge in free water although the evidence is insufficiently strong to prohibit the use of the system for under water escape in an actual emergency

Proposals for Further Work

Clearly the ideal method of establishing the safety of the Mk IV seat and Type 4 gun would be to carry out a series of free-water firings with human and animal subjects but because of the cost of the seats and the considerations discussed this is not possible It is proposed, therefore to make further tests with the rig this time at Admiralty Hydro Ballistic Research Establishment Glen Fruin investigating the pressure pattern around the rig by means of arcs of transducers This should show whether there is any focusing of the pressure waves

Sheep will also be exposed to blast from a Type 3 gun, for human underwater

ejections have been made with this without significant injury and any injury to the sheep in this case would strongly suggest that the rig itself was making a major contribution

Lastly a small number of free water firings with specially strengthened Mk III and Mk IV seats will be necessary to confirm the findings in the rig tests

Acknowledgments

It is a pleasure to acknowledge the assistance of the Royal Naval Physiological Laboratory who designed and maintained the rig provided the sheep and were responsible for the diving arrangements In particular I am indebted to Dr H C Wright whose knowledge of the pathology of underwater blast is unrivalled and who not only was responsible for the anaesthesia but also performed the autopsies

The photography was carried out by the Photographic Section H M S *Vernon* supported by A & A E E Boscombe Down instrumentation by the Electronics Section Institute of Aviation Medicine and the underwater communications system was designed and constructed by the Admiralty Underwater Weapons Establishment I also acknowledge the co-operation of the Admiralty Experimental Diving Unit, the Martin-Baker Aircraft Co and the Director General Aircraft (Admiralty) The trial was sponsored by the Ministry of Aviation and I am grateful to the Officer Commanding Royal Air Force Institute of Aviation Medicine, for permission to publish this report

A SURVEY OF SUCCESS AS A PILOT IN TERMS OF VISUAL STANDARDS

By Surgeon Commander J. KEELING, R.N.

THE standard of visual acuity required of candidates for pilot's duties in the Fleet Air Arm has varied over the years but has always been somewhat less than 6/6 6/6 that is somewhat less than that which may generally be regarded as normal visual acuity. The Central Air Medical Board has for some time suspected that those candidates who have been accepted for flying training with a sub-normal acuity have enjoyed a lower rate of practical success as a pilot than have their contemporaries with an acuity of 6/6 or better.

The permitted limits of heterophoria have not been varied for some time however where considered practicable those falling outside the standard have been given orthoptic treatment in an attempt to bring them within the requirements. Even though the ophthalmic results may have been satisfactory a subsequent relative lack of success as pilot has been suspected in these men.

Conditions have recently remained sufficiently static for a survey to be made of the progress of 459 accepted volunteers for pilot training of these 193 failed during training courses 30 have been killed, 22 suffered a psychological breakdown related to flying and the remainder 214 continue to serve as pilots. These hundred and fifty nine of the candidates had normal vision under the terms at present being considered 75 had an acuity below 6/6 6/6 and 25 had attained the ocular muscle balance standards only after orthoptic treatment.

The first comparison which may be made is between the 193 who failed their training and the 214 who continue, apparently successfully. The overall failure rate has been 47 per cent, but for those with a sub-normal acuity it has been 63 per cent and 71 per cent for those who received orthoptics.

Although the numbers in the selected groups are relatively small the difference between these percentages is statistically significant.

Having eliminated the training failures consideration may now be given to the remainder, who are in general terms, successful. The relative success of these men may be approached in several practical ways and their flying accident records will first be dealt with. These 214 pilots have been involved between them in 206 accidents. The figures for each group are interesting the 23 with low visual acuity have sustained 23 accidents, the 7 men who required orthoptic treatment have been in 5 accidents and the 184 with normal vision have had 178 flying accidents. Overall accident rates therefore do not appear to be influenced by the visual ability of the pilots.

Some accidents after official investigation are attributed to error on the part of the pilot. Thirteen per cent of the pilots with a sub-normal acuity have been in acci-

dents attributed to their own error. 14 per cent of those who had undergone orthoptic treatment were so involved, and 16 per cent of those with normal vision have had a pilot-error accident. These rates are derived from small absolute numbers, and do not differ significantly.

To have sustained a psychological breakdown related to flying may be held to indicate a lack of success as a pilot. There were 22 such cases in this sample, and only 5 of them later returned to flying duties. The normal vision group accounted for 14 of the cases, and for all 5 of the recoveries. The group having sub-normal visual acuity included 8 psychological cases; not only does this represent a much higher incidence rate, but also there were no recoveries in this group. The group which had undergone orthoptic treatment has not accounted for any case of psychological breakdown at all.

The final factor indicative of success as a pilot which will be considered is the professional assessment of flying ability which is formally reported on every aviator at annual intervals. Of the 214 pilots initially referred to as generally successful, 56 have not yet received their first annual assessment, and no assessment has been made available for a further 9 experienced pilots, leaving 149 figures to be analysed. The assessment is made on an integer scale from 1 to 9, although 5 is nominally the "average" mark, the actual mean of the 149 assessments is 5.57. This mean is conveniently located to enable a division into above-average pilots, who have an assessment of 6 or better, and below-average, that is a 5 or lower. Of the 149 pilots with known assessments, 53 per cent of the normal vision group have been assessed above the mean, 29 per cent of those with sub-normal acuity and only 20 per cent of those who received orthoptics have been assessed above the mean.

To summarize, and putting together all the postulated success criteria, the rates for confirmed overall success as pilot may be given as 49 per cent for those having normal vision, 30 per cent for those with a sub-normal acuity, and only 23 per cent for those who had received orthoptic treatment. In absolute numbers, and grouping together the two forms of visual deficiency, of the 100 men with such deficiency who attempted flying, only 7 (that is, 7 per cent) have achieved an above-average professional assessment, and only 4 have no assessment as yet. Of the 359 men with normal eyesight, an above-average assessment has been given to 65, that is to 18 per cent. No less than 61 remain without known assessment in this group, and some of these will almost certainly in the future cause an increase in the figure of 18 per cent. The difference between these two rates is highly significant.

Finally, may it be asked what are the variety of clinical findings underlying the low visual acuity and poor ocular muscle balance, and whether any particular clinical condition points to lack of success. Suffice it to say that analysis of the results of refraction, and of the different forms of heterophoria, does not demonstrate any such indication.

It may therefore be concluded that, no matter what the underlying clinical defect, the possessors of sub-normal eyesight have only about half the chance of becoming successful pilots by comparison with their visually-normal contemporaries.

UNDERWATER ACCIDENTS

By Surgeon Captain S MILES, R N.

UNDERWATER accidents as such need special consideration largely because as compared with accidents occurring on land a greater percentage of them are fatal Thought must first be given as to the reason why this is so for, although certainly less common than road domestic and industrial accidents they are, with the growing interest in skin-diving and other pastimes on the increase With the new pattern of naval diving where the individual is no longer connected to the surface by his air-hose and life-line but may be freely swimming the change of responsibility from the surface to the man underwater must increase the risk of accidents

When an accident happens on land unconsciousness is a common occurrence This in itself need not be a serious consequence and a casualty may remain at the site of the accident until help arrives and even though this may be delayed for several minutes, the outcome is by no means always fatal In the water however unconsciousness unless help is *immediately* available inevitably leads to drowning This most important fact must be remembered when underwater accidents are being studied or when safety regulations are being prepared

Underwater accidents tend, on the whole to be individual in character affecting only one man and rarely have the dramatic appeal of a road, factory or domestic accident where there may be considerable destruction of property and extensive bodily injury They are often isolated unobserved and rarely create attention until the victim is recovered This difference makes the study of these accidents easier to interpret if the body is recovered early Post mortem examination may reveal the true cause as there is no masking by the destructive effect of impact

Accidents in the water may be due to

1 Lack of experience
2 Neglect of precautions
3 Failure of equipment
4 Illness

Lack of Experience

This is a frequent cause, a common example of which is the individual who with no training and little knowledge may having seen the obvious enjoyment of others don a breathing set and jump into the water Not being familiar with an adverse environment, minor mishaps such as the flooding of a face-mask, readily cause panic and underwater panic is fatal

On land It is natural for anybody who is in danger to run away from it and this involves desperate and excited activity In water such activity rapidly leads to exhaustion and achieves nothing in the way of escape from an adverse situation The

experienced underwater swimmer faced with a crisis will be calm purposeful and slow in his reactions if he is to survive

Neglect of Precautions

In naval diving and indeed in any well organized "sub-aqua" club safety precautions are very well established and strongly enforced Experience has shown that accidents which do occur are in at least 75 per cent of cases due to failure to observe these important regulations A classical example of this is that of a diver who, contrary to regulations, used a cutting torch when working in the compartment of a sunken submarine which was being salvaged The presence of oil fuel on the surface of the water trapped with an air pocket above it, produced an explosive mixture which was ignited by the torch, blew the diver through the hatch breaking his back immediately However experienced and blasé divers and underwater swimmers become they must at all times accept the absolute need for any safety regulations Fortunately most of them do

Failure of Equipment

Generally speaking this is rare since most divers and swimmers soon appreciate the fact that their lives depend upon the integrity of any apparatus they may use Where mistakes do occur these are again usually due to personal error and quite a number of them result from carelessness in charging cylinders There are far too many cases on record where oxygen cylinders have been filled with air or even nitrogen

Illness

In the practice of underwater medicine there is a tendency to forget that medical emergencies may cause unconsciousness especially as the majority of people who are working or playing underwater are generally speaking, of a high standard of physical fitness Even so on a purely statistical basis though rare, some crises must occur in or under water and result in the odd surprise as, for example, epilepsy coronary thrombosis or cerebral hæmorrhage

Quite recently a strong young man of 22 years fell ill whilst in the water and lost consciousness as he was climbing a ladder to get back on board his ship Falling back into the water he disappeared and was found on the bottom by other divers two hours later with his set in place and still alive Indeed they had heard his groaning under water Back on board his ship he recovered consciousness and seemed to be reviving until he collapsed with a copious lung hæmorrhage and died some three hours later Post-mortem examination in this case revealed an occluded coronary artery and evidence of chronic selerosis a most unexpected finding.

There are quite a few cases on record where divers have entered the water suffering from some apparently mild respiratory infection and have quickly become desperately ill and some have died having in a short space of time developed an acute hæmorrhagic virus pneumonia Though the effect of breathing gases and particularly oxygen, under pressure on the pulmonary epithelium is little understood there seems to be no doubt whatever that any pulmonary infection is rapidly spread and in

many cases may produce a frightening picture. It is therefore, of paramount importance that no one who is feeling in any way off colour should go underwater, and careful screening for pulmonary illness is important.

Non-fatal Accidents

It has been pointed out that accidents in water are fatal not because of their severity but because no one is available to effect immediate rescue. Consequently it is essential to regard any accident involving unconsciousness in water as potentially lethal and all should thoroughly be investigated to find the cause and steps taken to prevent a recurrence.

A detailed study of 83 accidents has been made and a tabulation of causes is given in the following table.

Cause	No. of Cases Non-fatal	Fatal	Total
Cause Unknown	7	1	8
Oxygen Syncope	21	—	21
Anoxia (set exhausted, faulty or wrong mixture)	14	3	17
Illness in Water			
(i) Epilepsy	3	1	4
(ii) Pneumonia	3	1	4
(iii) Coronary Thrombosis	—	1	1
Asphyxia (e.g. flooded set)	6	9	15
Oxygen Poisoning	4	4	8
Burst Lung			
(i) Emphysema	1	—	1
(ii) Pneumothorax	1	—	1
(iii) Air Embolism	1	—	1
Shark Attack	—	1	1
Underwater Explosion	—	1	1
Total	61	22	83

Nothing, of course, can be said about the cases which are labelled as CAUSE UNKNOWN. Of the 21 classified as OXYGEN SYNCOPE, 15 occurred during the early weeks of training and all were breathing oxygen. Oxygen has been shown to lower the syncope threshold and where oxygen is breathed underwater and other factors exist such as hyperventilation of anxiety, fear, fatigue, hangover, hunger, poor vasomotor tone or increased intra-pulmonary pressure, a summation of two or more of these syncope-promoting factors may result in a loss of consciousness.

ANOXIA is commonly due to a wrong mixture being put in the apparatus or mal-adjustment of the set itself. Where swimmers dive without apparatus, e.g. some spearfishermen, there is a practice of hyperventilating before entering the water which has led to disastrous results. It cannot be too strongly condemned. Hyperventilation reduces the alveolar CO_2 content and prolongs the breath holding period

If this is followed by strenuous underwater swimming, particularly associated with the emotional challenge of hunting a large fish, the available oxygen may be rapidly reduced. When the hunter turns to come to the surface a further lowering of oxygen partial pressure might easily reduce this pressure below that needed to support consciousness. Many lives have been lost through this cause.

OXYGEN POISONING, BURST LUNG and UNDERWATER EXPLOSION are special conditions associated with naval diving which are fully described elsewhere. The risk of burst lung, however, must be mentioned as one occurring to those who are obliged whilst underwater to abandon a faulty breathing apparatus. Unless they are relaxed and allow expanding air to escape during ascent, lung damage may occur. The practice of training underwater swimmers in open water to exercise this form of free ascent must be strongly discouraged and should only be allowed under trained supervision and when facilities for immediate recompression are available.

Finally, the aim of all concerned with man in and under water must be to make his activities safe. This can best be achieved by impressing upon all who go under water of the need for readjustment to a new environment. The awareness that so many accidents are due to human error must be realized by those who train the swimmers and divers.

DECOMPRESSION SICKNESS: PRESENT STATUS

By Commander KENNETH R COBURN, U S N.

Introduction

ALTHOUGH the introduction of the pressurized cabin into military and civilian aircraft has largely solved the problem of decompression sickness in aircrew systems failure has occurred and will continue to occur. Consequently the problem of decompression sickness, while reduced in incidence is still a very real entity. This is pointed out by the continuing requirement of the Royal Navy for all aircrew to submit, at regular intervals, to the High Altitude Selection Test (H A S T), administered by the Royal Naval Air Medical School. The H A S T consists of three exposures of one hour's duration on alternate days to a simulated altitude of 37,000 feet. Rates of ascent and descent are standardized and all possible variables are carefully controlled. As a consequence of this test all aircrew are categorized as A—essentially no symptoms, B—minor symptoms or C—serious symptoms. Aircrew classified A or B have no restrictions placed upon their flying, however those persons placed in Category C i e those exhibiting respiratory cardiovascular or central nervous system symptoms are not permitted to fly above an actual altitude of 30,000 feet

Aetiology and Symptoms

In spite of the vast amount of research which has been done on the problem of decompression sickness the precise mechanisms of bubble formation and pain production, as in the bends are still in question. It has been definitely established that nitrogen plays an important if not primary, role in the genesis of the disease. The practice of breathing 100 per cent oxygen for 30 to 60 minutes prior to ascent to altitude washes out better than 50 per cent of the body's total content of nitrogen and thus markedly reduces the incidence of decompression sickness. The variations seen in the incidence of decompression sickness are thought to be due to differences in individual factors such as rate of nitrogen elimination and amount of total body fat. The latter factor is important as nitrogen is about five times more soluble in fat than in muscle tissue. Analysis of the bubbles themselves have shown that they contain oxygen carbon dioxide and water vapour in addition to nitrogen; however once a bubble is formed by whatever mechanism all gases in solution in the surrounding tissue fluid or blood would rapidly diffuse into it and thus cause it to increase in size

Regardless of the gaseous composition of the bubble or its site of origin, i e intervascular or extravascular the location of the bubble determines the symptoms of decompression sickness which appear. It must be pointed out that the bubbles though demonstrably present do not necessarily produce symptoms. However they are of great potential danger as they are less easily eliminated via the lungs than gases in solution in the blood plasma

The symptoms of decompression sickness are varied and, as mentioned above, appear to be dependent upon bubble location. These symptoms are:

Skin manifestations—these include subjective sensations of itching and prickling and objective observations of intracutaneous blobs, subcutaneous emphysema and mottled skin. It is thought that local vasospasm is responsible.

Bends—this symptom consists of various degrees of pain, usually in the joints. The degree of pain has been classified as follows:

Grade I—slight intermittent pain
Grade II—moderate, steady pain
Grade III—severe pain
Grade IV—incapacitating pain, pre-syncopal

The presence of bubbles in the joints has been demonstrated by X-ray.[1,2,3] When bubbles were present in the periarticular tissues there was a high correlation with pain; however there was no such correlation between pain and the presence of gas in the joint space. This is demonstrated in Table I.[4]

TABLE I
Analysis of roentgenographs of knees taken at a simulated altitude of 35,000 feet

	Total Number of observations	Streaking in Popliteal Fossa		Discrete Bubbles in Popliteal Fat Pads		Gas in Joint	
		Present	Absent	Present	Absent	Present	Absent
Bends pain							
Present	57	48	9	49	8	57	0
Absent	28	9	19	3	25	28	0

(Adopted from E. B. Ferris, J. R. and G. L. Engel in Fulton[4])

Bone Changes—although bone changes have been reported in caisson workers since 1910[5] they were not observed in low-pressure chamber workers until 1956.[6] At this time a survey was made of 40 U.S. naval personnel employed as inside observer/instructors in low pressure chambers. Long-bone roentgenographs were taken and sent to the author. The interpretation was done by a radiology consultant. In seven individuals a total of eleven characteristic bone lesions was found, an incidence of 17.5 per cent. The distribution of these lesions is shown in Table II.

The distribution of these lesions is generally similar to the distribution of those seen in caisson workers as shown in Table III. These data were compiled from several sources.[7,8,9,10] In general the lesions appeared as areas of increased density. In one case with bone proliferation into the medullary cavity and in another there was a flattening and asymmetry of the articular surface of the left femoral head, suggesting aseptic necrosis. These lesions were identical in appearance to those seen in caisson

TABLE II

Distribution of bone lesions in 40 low-pressure chamber workers

Bones Involved	Lesion Distribution	
	No of Lesions	Percentage
Femur		
Left	1	9 0
Right	3	27 0
Humerus		
Left	0	0 0
Right	2	18 0
Tibia		
Left	3	27 0
Right	0	0 0
Ulna		
Left	0	0 0
Right	1	9 0
Fibula		
Left	1	9 0
Right	0	0 0

TABLE III

Distribution of bone lesions in 40 affected caisson workers

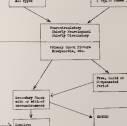
Bones Involved	No of Lesions	Percentage
Femur		
Left	26	22 2
Right	32	27 3
Humerus		
Left	26	22 2
Right	19	16 2
Tibia		
Left	6	5 1
Right	7	6 0
Fibula		
Left	1	1 0
Right	0	0 0
Total	117	100 0

workers[7,9] It must be mentioned that in a recent survey of 579 U S Air Force low pressure chamber personnel Berry[11] failed to find any lesions of similar type The reasons for this disparity are unknown

Chokes—this is perhaps a misnomer as the symptom consists of an initial burning sensation in the mediastinum which is aggravated by deep breathing This soon leads to coughing which can become very severe Immediate descent to sea level is indicated It is generally thought that the chokes are due to irritation of the mucous membranes of the broncho-pulmonary system however the possibility of the presence of rather large numbers of small bubbles in the pulmonary arterial system although not demonstrable cannot be excluded

Staggers—are thought to result from a bubble occluding a small cerebral blood vessel and thus producing a rather discrete area of ischæmia The name derives from the staggering sometimes seen if the locomotor zones are affected Other neurological phenomena ranging from scintillating scotomata to paralysis have been observed There is an interesting hypothesis concerning neurological symptoms and

Figure 1—Diagrammatic representation of the events seen during the course of decompression collapse syndrome

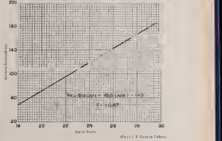


(From Adler June 1950)

the fact that in many cases they are preceded by chokes. Those that feel that bubbles in the pulmonary vessels act as causative agents of the chokes argue that the descent to sea level compresses these bubbles to very small size and thus allows them to pass into the systemic arterial system where they can reach the cerebral circulation, thus giving rise to the neurological phenomena.

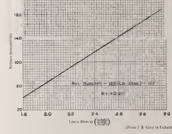
Decompression Collapse Syndrome—this symptom is rarely observed but represents the existence of a grave condition. The onset may be abrupt or insidious and the symptoms seen may be either chiefly circulatory, chiefly neurological or varying combinations of both. The primary shock phase may pass with no serious sequela; however many patients, following a relatively lucid period, succumb to a secondary shock phase. This is shown diagrammatically in Figure 1.[12] Until recently, treatment for this condition has been of a strictly supportive nature, although several patients have shown improvement following spinal puncture.[12] Two cases have been treated by compression to increased atmospheric pressures in submarine recompression chambers.[13,14] In both of these cases the patients were considered moribund at the time the compression therapy was instituted; however, within minutes of being

Figure 2—The relationship between age and relative susceptibility to decompression sickness



(From J. S. Gray in Fulton)

Figure 3—The relationship between linear density and relative susceptibility to decompression sickness



(From J S Gray in Fulton)

exposed to the increased pressure the patients exhibited virtually no symptoms and had become lucid

Modifying Factors

Age is an important factor in the susceptibility to decompression sickness The correlation coefficient of this relationship is +0.87 and is stated mathematically as

relative susceptibility = 10.8 (age)—145[15]

Figure 2 depicts the relationship graphically

The fact that nitrogen is about five times more soluble in fat than in muscle tissue has led to considerable effort to relate body type to decompression sickness susceptibility A high degree of correlation +0.91 has been found by Gray[18] between linear density (weight/height) and susceptibility to decompression sickness This relationship is shown graphically in Figure 3 As with age this can be stated mathematically

relative susceptibility = 122 (linear density)—177

Exercise at altitude is known to increase the susceptibility to decompression

sickness most particularly to the bends. The cause for this is in doubt. One group maintains the primary reason is a local CO_2 build up while others maintain the tension produced at muscle insertions causes greatly hastened bubble formation.

Various other physical or chemical variables have been evaluated to determine their role in the etiology of decompression sickness but perhaps the most bizarre is demonstrated by Table IV.

TABLE IV

The relationship between fluid intake and susceptibility to decompression sickness

Fluid Intake in Glasses per day	Susceptible to Decompression Sickness		Resistant to Decompression Sickness	
	Number	Per cent	Number	Per cent
3—5	80	67	39	33
6—8	287	64	165	36
9—11	242	58	173	42
12—14	76	44	96	56
15—17	12	26	34	74
18—20	0	0	7	100

(From S. F. Cook in Fulton[16])

It is pointed out that varying an individual's fluid intake has no effect; rather it appears that the individual's desire for fluid is the important facet of this interesting finding.[17]

Thus we see that although the literature dealing with the subject of decompression sickness is vast the basic etiology is still clouded. If we are to finally conquer the problem particularly with respect to decompression collapse syndrome, a new approach must be made and vigorously prosecuted.

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INTERROGATION AND INDOCTRINATION

By Surgeon Captain E BOYD MARTIN, R N

THE Korean War faced the western world with an entirely new problem Never before in history had so many prisoners died in captivity and never before had so many collaborated with the captors As a result of investigations in this country and in the United States into why this had happened committees were set up to decide what could be done to avoid such things in the future In both countries it was decided that training programmes in resistance to interrogation were necessary

In the U K such training came naturally under the Army since they were the main users Exercises were arranged and after each the programme was modified as lessons were learned When all seemed ready the other Services were invited to take part

These exercises have never been popular The main criticism levelled against them is that it is impossible to achieve anything like sufficient realism Anyone taking part with such thoughts in his mind is due for a very sharp awakening

My connection with these things was relatively by chance As the then President Central Air Medical Board I was required to see what reasons I could find for the ease with which naval aircrew talked under interrogation Two obvious first steps were taken first to do a course for interrogators second to attend an interrogation exercise

With the background knowledge gained one was able to begin some study of the time problem ' Why? "

Two things were immediately clear The interrogating team were all dedicated to their task and prepared to go to any lengths within the bounds of the Geneva Convention to achieve their object So far as naval aircrew were concerned the whole thing was a bit of a skylark—even if an unpleasant one Most of them appeared never to have been properly briefed for the task The problem seemed very simple If properly briefed on what to expect after capture and what was expected of them then there would automatically follow improved naval performance This did not work out. Performance was in no way better

The next possible explanation lay in the nature of the briefing This was done by the interrogating team and even though scrupulously fair it was naturally suspect Who could blame the runners for the belief that the whole briefing was no more than a preliminary softening-up process ? Neutrals were called in to assist with briefing No detail of technique was not explained Nothing was left out Nothing was not explained in full The next exercise was awaited with certainty of success The results again showed no improvement at all. Briefing was not the answer to the problem

By this time one was oneself acquiring a much wider range of experience and of material to study Two exercises in particular provided food for thought In the first the runners (R C A F) had talked widely and freely In the second, largely the same

personnel had had 100 per cent success in resisting interrogation. There were two main differences in the two exercises. After their performance in the first the R C A F were under a high degree of retributive threat from their own Service. They were also faced with an interrogating team that was determined to win almost regardless of cost and the Geneva Convention.

It was basically from these exercises that I arrived at what I believe to be the true reason for people talking in these circumstances. Further they provide a basis for the success of what was called brainwashing but is now called indoctrination. The basis lies in Pavlov's experiments in the conditional reflex of the hungry dog. First he trained a dog to salivate, not when it was shown food but when it heard extraneous auditory stimuli. The stimulus could be changed but the dog would salivate for each. When all were applied together the dog would become confused and apathetic and do nothing. Shown its normal master it would revert to being just a dog wanting affection.

So it is with man. We have all been, from birth, conditioned into a pattern of life. With luck we become normal citizens. Normality is elastic and means only that we have not had to be segregated in a mental hospital. We do it at the price of acquiring a mass of repressions and frustrations with which we have to live with more or less success. Common to us all is a need for affection, for warmth and friendship.

Then comes capture. Generally it is preceded by a terrifying experience: battle, being shot down, having one's ship sunk. Bewildered, frightened, weary physically and mentally, one is thrust into the unknown. Detached from all normality a natural reaction is to sink into the apathetic state of Pavlov's dog and to despair. Harsh treatment may shake one out of this and produce determination to resist, but a soft friendly approach tends to bring an acceptance of this spurious friendship and one is then on one's way down a slope of increasing steepness.

A prisoner of war is required to answer four questions: his name, rank, date of birth and number. Beyond these four answers he must politely decline to go. He must decline since once he goes beyond then he is at once committed to the slope. It comes out time and again that once one has gone beyond the four required answers it becomes increasingly difficult to halt.

This is equally true of prisoners in civil life. There is, especially for first offenders, the period of apathy and despair. This may present and produce a condition of withdrawal eloquently described as barbed wire disease. If it does not persist it is the task of the tobacco barons to bring the prisoner under the relentless discipline of his fellow prisoners and to prevent any collaboration with the authorities.

In the prisoner of war camp it is the task of the captors to prevent the formation of any disciplinary system among the prisoners. Anything that can be done to undermine their normal Service discipline is done. The hardy and the rebels are weeded out and segregated. Mutual distrust is actively fostered among the rest. The Chinese record of success in Korea was staggering. The prisoner failure rate varied directly with the standard of living of the nations concerned: the higher the standard the higher the failure rate. The Turks, normally with the lowest standard of living, came through unscathed: none died in captivity, none collaborated. This resulted from two things: national pride and discipline, particularly self discipline. This is in the sharpest

contrast with the other nations in whom it is estimated that of those who died some 30 per cent died less from physical illness than from giving up the struggle

Three facts arise from interrogation exercises One is that those who have been through the mill all agree that it was a worthwhile experience though they do not want to repeat it A second is that those who have done repeat exercises invariably do better with each exercise the third is that none of the prisoners ever say the exercise lacked realism

The exercises become more difficult as the interrogators learn from their mistakes On the other hand resistance to interrogation is improving We have come belatedly to what I believe is the true basis of the problem Briefing must be improved and the improvement will come from being able to brief on *why* and *wherefore* instead of plain *do* and *don t*

NAVAL MEDIC… …MPASSIONATE FUND
ACCOUNT OF RECEIPTS AND PAYMEN… …R THE YEAR ENDED 31st DECEMBER, 1961

	£ s d	£ s d
Balance at Bank on 31st December 1960 —		
Current Account	1 087 1 2	
Deposit Account	12 13 5	
		1 099 14 7
Interest on 3½% Conversion Stock	66 10 0	
Interest on 4% Consolidated Stock	179 18 6	
Interest on 3½% War Stock	35 0 0	
Interest on 4½% Conversion Stock, 1964	137 16 4	
		419 4 10
Refund of Income Tax on Deeds of Covenant		96 14 6
Refund of Income Tax on 4½% Conversion Stock		43 11 11
Interest on Deposit Account		8 0
Subscriptions		242 11 0
Donations		14 14 0
Bequest from the Estate of the late Surgeon Captain Robert Kennedy R N		1,000 0 0
		£2 916 19 6

I certify that I have examined the above Account of Receipts and Payments and found it to be correct and in accordance with the books and records of the Fund and that, with one exception, all my requirements as Auditor have been met

No voucher or statement has been produced in support of the amount of £96 14s 6d shown as Refund of Income Tax on Deeds of Covenant

A certificate of the Balance on Current and Deposit Accounts at the National Provincial Bank Limited on 31st December 1961, is attached together with a list of Stocks standing in the names of the Trustees for which Stock Certificates were held by the National Provincial Bank Limited for safe custody

Income Tax amounting to £87 3s 8d deducted from Interest on 4½% Conversion Stock, 1964 received during the year is recoverable from Inland Revenue

Subscriptions received include the sum of £3 3s —in arrears for previous years.

Subscriptions unpaid at 31st December 1961 amounted to £10 10s —as follows

1959	£3 3 0
1960	£3 3 0
1961	£4 4 0
	£10 10 0

31st January 1962.

(*Signed*) Wm C McNicol
Chartered Accountant, Auditor

	£ s d	£ s d
Awards to Widows and Orphans		460 0 0
Clerical Assistance		30 0 0
Auditor		3 3 0
Inland Revenue Stamp on Deeds of Covenant		2 6
Stationery and Postage		12 3
Cheque Book		8 0
Purchase of £992 Conversion 4½% Stock 1962		1 000 0 0
Balance at Bank on 31st December 1961 —		
Current Account	1 409 11 8	
Deposit Account	13 2 1	
		1 422 13 9
		£2 916 19 6

In addition to the above Cash Balance Stock to the following amounts were standing at the close of Accounts at the Bank of England in the names of the Trustees

£ s d	
4,498 3 2	4% Consolidated Stock
1,000 0 0	3½% War Stock
1,900 0 0	3½% Conversion Stock
5 000 0 0	4½% Conversion Stock 1964
992 0 0	4½% Conversion Stock 1962

15th January 1962

(*Signed*) M H Adams
Surgeon Captain, R N
Honorary Treasurer

Articles

THE CHOLERA OUTBREAK IN HONG KONG—1961

By Surgeon Lieutenant-Commander J. M. DAVIES, R.N.

Historical

From 1936, when the Sino Japanese war broke out, until 1947, there was cholera in Hong Kong every year. The epidemic years were

1937 1,690 cases, 1,082 deaths
1938 547 cases 364 deaths
1946 514 cases 239 deaths

The absence of cholera since 1947 is surprising because of the huge influx of refugees from the mainland, many of whom are still living in insanitary and overcrowded conditions. The population at risk is now over three million.

Warning

Early in August there was a report that cholera had reached the epidemic stage in Toishan, Kwangtung Province. The disease later spread to the southern parts of the province, including Canton.

On 14th August, following a report that a suspected case in Macao had been confirmed to be suffering from cholera, the Hong Kong Medical Department took precautionary measures against the disease being introduced into the colony. Quarantine restrictions were imposed against entries from Macao and China by land or sea while quarantine stations for ships, including junks and sampans, were established at Kowloon Bay, Stonecutters Island, Tai O and Cheung Chau.

On 15th August, Dr. The Hon. D. J. M. Mackenzie, Director of Medical and Health Services, broadcast to the colony and advised the public not to be anxious but to be careful. Meanwhile the health authorities were doing everything to prevent an outbreak.

The First Cases

On 16th August there were two suspected cases, a 12 year old boy who was brought in dead to the Kowloon Public Mortuary from a junk at West Kowloon, and a 6 year-old girl who came from the western seaboard of the New Territories, who was admitted to hospital.

Sections of two hospitals were equipped and staffed to deal with cholera cases. A wing of the old Mental Hospital at Sai Ying Pun and the top floor of the Laichikok Hospital.

A quarantine centre for the isolation of contacts was opened at the Chatham Road Camp.

Long queues lined up at Government health centres to receive anti-cholera inoculations. Inoculation teams began to carry out mass inoculation campaigns in Aberdeen, Shaukiwan, Tsimshatsui and the typhoon shelters in the harbour, which

were the areas most at risk also in the New Territories particularly in the Castle Peak and Deep Bay areas

Health Inspectors intensified their investigations at local restaurants foodstalls and public eating places Unpurified water sources in rural and urban areas were checked Disinfection of junks was started

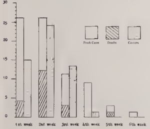
On 17th August four cases were confirmed and Hong Kong was declared an "Infected Area" under International Sanitary Regulations

The two additional cases were a man from Aberdeen taken to the Sai Ying Pun Hospital and a 48 year-old woman from the Yuen Long area who was admitted to Laichikok Hospital

Progress of the Outbreak (See Histogram and Map)

By the end of the week following the 16th August, 26 cases had been discovered and the same number were found during the second week Among these 52 cases there were eleven deaths a far lower proportion than in any previous recorded outbreak in the colony Moreover of these eleven, seven were brought in dead Another notable feature was that the cases were distributed mainly among the boat-dwelling community and to a lesser extent among street-hawkers

CHOLERA IN HONG KONG AUGUST—SEPTEMBER 1961



KEY

A	Shteung Shui	1	I	Kowloon Bay	11
B	Sha Tin	1	J	West Central Victoria	10
C	Yuen Long	2	K	Wanchai	1
D	Taipo	8	L	Causeway Bay	1
E	Castle Peak Bay	1	M	Shaukiwan	4
F	Tsun Wan	3	N	Aberdeen	4
G	Tsing Island Bay	1	O	Little Hong Kong	1
H	West Kowloon	22	P	Peng Chau	3
			Q	Cheung Chau	1

From the end of August there was a steady decline in the incidence of cases and the last one recorded was on the 26th September The total number of cases was 76 among whom there were 15 deaths

The vibrio responsible was the El Tor sub-type of the Ogawa strain

Quarantine of Contacts

The isolation of contacts for investigation and observation was started immediately and by the 18th August there were 54 contacts in the Chatham Road Centre This presented a considerable social problem and a constant service between the contacts and their families was kept up by hospital almoners The head of every family sent admitted to the Centre was invited to the almoner's office to discuss any family affairs

The importance of quarantine was emphasized by Dr Mackenzie in his second broadcast to the colony on 29th August He pointed out that of the 33 cholera carriers so far confirmed 31 had come from contacts isolated in the Chatham Road

Centre By the 30th September, 53 carriers had been found They responded to treatment with streptomycin A further analysis of the contacts in quarantine showed that 7 6 per cent were carriers and of these 5 3 per cent were boat people

The Chatham Road Centre was closed on 17th September by which time 711 contacts had been discharged Of these only three escaped!

The Inoculation Campaign

By 20th August, four days after the first cases approximately one million people or a third of the population of the colony had been inoculated So enormous had been the response, that by the 20th August, vaccine was in temporary short supply and it was decided to concentrate all available supplies in the potential danger areas During the next few days, supplies of vaccine from overseas Sarawak Australia India, U K and the U S A arrived and helped until the colony s own production of 125 000 c c daily was organized

Helicopters of the Hong Kong Auxiliary Air Force were used to take teams to outlying areas

On 26th August it was estimated that nearly two million people had been immunized three quarters in Government inoculation centres

The remainder of the population was slow to respond and on the 29th August Dr Mackenzie appealed to them He said " All we need is the co operation of the missing million "

By 4th September it was considered that 90 per cent of those living in the New Territories and other danger areas were covered

Environmental Hygiene

Health Inspectors of the Urban Services Department worked to control the four principal sources of infection food water flies and human excreta

Dangerous food exposed for sale without proper protection against contamination was seized and destroyed

A survey of all wells in the western part of the New Territories was made

As an extra precaution the Water Authority doubled the amount of chlorine used to treat the colony's water supplies

The collection and disposal of night soil received special attention

Cholera in Macao and China

Macao had twelve cases and six deaths during August and September There were conflicting reports as to the extent and even the existence of a cholera epidemic in the Kwangtung Province of China Since this province borders on the colony and there is considerable intercourse by both land and sea the risk of new sources of infection had to be considered The following extracts from the *South China Morning Post* are relevant

" *Peking August* 20

Reports spread abroad, particularly in Hong Kong about an alleged cholera epidemic raging in Kwangtung Province seem to be untrue Officials in

Peking have refused to react to what they termed as ' one of daily fabrications concocted by espionage and intrigue dens in Hong Kong

" *August 23—Inoculations in Canton*
A college student from Canton reported that the Canton Health Authorities had organized mass anti-cholera inoculations since June He added that the authorities had also advised students from Toishan not to return to their district because of an outbreak of cholera there especially in the Yeungkiang area All routes to Yeungkiang had been cut off the student said

Washington August 22
The State Department spokesman today rejected emphatically Communist Chinese accusations that the United States was to blame for the cholera epidemic on the Chinese mainland The accusation Mr Joseph W Reap said is ' but another of a long series of Chinese Communist hoaxes by cruelly and inhumanly playing upon the sufferings and fears of people under their control for crass propoganda purposes Mr Reap said that a newspaper in Hong Kong quoted Communist Chinese officials as saying that agents of an American bacteriological warfare bureau are plotting the cholera epidemic in Southern Kwangtung '

" *August 24 Macao Newsletter*
News has reached here that over 15 000 have died recently in the counties of Toishan San Wui Sze Yap, Yong Ping and other areas near Macao In spite of the denial by the authorities in Peking, the situation in China is said to be deteriorating and almost getting out of control

September 1 The New China News Agency reported that 284 paracholera cases had been confirmed in Yeungkong Yeungchung and Tinpak counties in Kwangtung Province and the death toll to date is 28 persons The Agency however denied that the disease was of epidemic proportion as reported by U N World Health Organization last week"

Conclusions

There is a pandemic of the choleriform infection known as El Tor or paracholera in progress in South East Asia Starting in Thailand Laos and Cambodia in 1958 it has recurred in these territories in 1959 and 1960, and this year invaded Indonesia China Sarawak the Philippines Macao and Hong Kong

El Tor is a form of cholera which is said to be distinguished by its mildness and sporadic occurrence It has however a record of up to 66 per cent mortality when there is no attempt to prevent its spread while the clinical symptoms of the infection are indistinguishable from classical cholera Under the environmental conditions of Hong Kong for all practical purposes it was essential to treat it as the latter

The public reaction in Hong Kong certainly indicated an awareness of the danger Personal knowledge of how the disease was affecting relatives or friends in the

neighbouring province of [illegible] was widespread. The results [illegible] in the early overwhelming response to the mass inoculation programme, in the absence of any attempt to conceal cases and in the ready acceptance of isolation by contacts before being allowed to return to their normal dwellings and occupations.

Scene outside the sick bay, H.M.S. [illegible] 1961

THE ROYAL NAVAL MEDICAL CLUB DINNER, 1962

The annual dinner of the Royal Navy Medical Club was held in the Painted Hall at the Royal Naval College Greenwich on Monday 31st April 1962

The following guests and members were present

President Surgeon Vice Admiral W R S Panckridge, *C B Q H P*

G F Abercrombie, *V R D*
R M Adam
M H Adams
Professor Ian Aird
K P Allpress
L D Arden
Ven Archdeacon J Armstrong, *C B E, Q H C*
J E M Ayoub

K M Backhouse
G M Baird
J Matthew Banks
P J Barkham *O B E T D*
P Cowell Parkis *V R D*
F W Baskerville *C B E*
A Dennis Bateman *O B E V R D*
R W Bazeley
J S Beancroft
A C H Bell *F R C O G*
Dovm Bell
J H Bennett
M Bennett
R A Burnett
Robert Benson
G A Binns
N V Birrell
J A Blair
D Blacet
I B Bradbury
Professor Robert Bradlaw *C B E*
M Bainbridge
F G Burgess *M V O*
R A Bern
W A Barnett
H Jackson Burrows

E D Caldwell
F C W Capps
Steve Carstairs
M C Cartwright Taylor *C B*
Gordon Catford
W Rougier Chapman *V R D*
Duncan Chisholm
John A Chivers
D Churchill Davidson
H C Churchill Davidson
W F Cleland
D Clancy
E B C Cliff
J M Cliff
J H Cobb
Kenneth R Cobrim
A A Cochrane
Claude Cole
S N Cole
R R A Coles
I H Colley
P C Collinson *V R D*
H H Cook
C Foster Cooper
R D Cooper
J M Corall
J L S Coulter *D S C*
J Cox
Robert Cox, *M B E*
A G Cross
R M S Cross
P A Crow
Professor Desmond Curran *C B E*
H N Cristance

D G Dalgliesh *O B E*
H M Darlow
A Frazer Davidson
T F Davies
Professor T A Lloyd Davies
W F Davis
Bruce Davison
M Douglas Davys
Sir Michael Denny *G C B K B E D S O*
H A Dosey
T W E Dommett
C E Drew *M V O V R D*
J A Drew *C B*
A M Driscoll
T Driscoll
Professor A S Duncan *D S C*
R W Duncan
Ray Dyer

J Edgcombe Rowe, *J P*
W H B Ellis *A F C*
Rt Hon The Lord Evans *G C V O*
Malcolm Evans
R Byron Evans
William Evans
L J Evered

Sir Wilfred Fish *C B E.*
Larimer Fison
G L Fordyce
L Foss *O B E. V R D*
R H Franklin
J F D Frazer
W Fitzgerald Frazer
J D J Freeman

Harry Freestone
I W Froggatt *O B E*
A C Fuller *V R D*
Rodney H C Fuller *F R G S*

V O B Gartside *V R D*
A J Gaskell
Arnold Gee
A George
B George
Charles C Gethen
R C R Gethen
G A R Girl
E C Glover *V R D*
G E Godber
Victor Goldman
D L Goodridge
A H C Gordon Lennox *C B D S O*
H R Gray *V R D*
E Grey Turner *M C, T D Q H P*
Ivor Griffiths
W J Forbes Guild, *Q H S*
D P Gurd

A W Hagger *V R D*
W B Hales *T D*
W H Halstead
F L Hall
F R Hampton
John Happel
R G Harcourt
J W Harding
T T Hardy *V R D*
H J Harris
G A Hart *V R D*
C P Hay
E D A Hay
A Hegarty *D S C*
A N Hepburn
N S Hepburn
N G B Hersey
I H Heslop
M H Heycock
G de P Hinde *V R D*
J F Hobson
M Holdsworth
J Holford *O B E*

W Holgate *C B O B E*
C R Holland *D S C*
F G Hollands
M W H Holloway
D R Hughes *V R D*
W Hughes
E G Hunt *C B C B E*
John Hunter
M I Hunter

G S Irvine

Ian Jackson
E James
Sir Clifford Jarrett *K B E C B*
D S Jarvis
Anthony Jefferson
C C Jeffery
J Johnston
William S Johnston *V R D*
F Avery Jones

P K Kekwick *C B*
T D Kellock
R E Kelly
H K Kemp
Professor W E Kershaw *V R D*
J R Kirkpatrick
A P Kitchin
H E Knott *C B O B E Q H P*

F R Langmaid *O B E T D J P*
T A Lass
D Leeming
Sir Patrick Lee Potter *K B E Q H S*
Henry Lesser *C B E*
B S Lewis *D S C*
D C Lillie *V R D*
G Linley
J Lister
P D Lloyd
H W F Lowman
T Keith Lyle *C B E*

P I Mann
R G Maliphant
H J Malkin
H C Maltby *M C*
H S Marland
E Boyd Martin *O B E*
Peter Martin *V R D*
W B Martin
D Matthews
Sir Cyril May *K B E C B M C*
R A J Mayhew
A M McCall *V R D*
J D McCarter
C L T McClintock
Iain Macdonald
R S McDonald
J C J McGowan
I W MacGregor
W P E McIntyre *C B*
R A Mckeown *O B E V R D*
W McKinnel
M A C MacNeill
G Graham Macphee
J A Mead
M K Mead
R P M Miles
S Miles
Stephen Miller
R A Moga *V R D*
J E Morgan
B C Morison
Clifford Morson *O B E*
E V B Morton *V R D*
W E Morton
L A Moules
W L Mountain *O B E Q H D S*
M Murray

J N Nash
W J Nutter *T D*

K J R O'Connor
D O'Donoghue
D J D Donoghue
P Oliver
I Michael Ormerod
S P Osmond

P. B. Palmer
M. Partridge
Robert Percival
A. D. Petro *V.R.D.*
B. W. Pett *V.R.D.*
G. H. N. Phillips
Rex Phillips *O.B.E.*
H. R. Philpot
R. D. Plowman
Sir Arthur Porritt *K.C.M.G. K.C.V.O. C.B.E. F.R.C.S.*
S. H. R. Price
T. M. L. Price
J. G. Pritchard

I. A. B. Quarrie *V.R.D.*
H. Quinlan *C.B. Q.H.D.S.*

Talbot Radcliffe
James W. Rae
S. G. Rainsford
J. Mansel Reese *O.B.E. Q.H.P.*
A. Riddell
A. D. Richa
C. Roberts
Douglas Robertson
Alan Robinson
P. K. Robinson
R. H. O. B. Robinson
J. P. G. Rogerson
J. Keith Ross
M. G. Ross
D. C. L. Rowe
G. B. Rowe *D.S.C.*
N. L. Rowe
E. T. S. Rudd *C.B. C.B.E.*
Alan Ruffman *V.R.D.*
N. Lloyd Rusby
J. F. Ryan

G. C. Sawyer
Professor R. W. Scarff *C.B.E. F.R.S.E.*
R. Scoggins *C.B.E. Q.H.D.S.*
T. Holmes Sellors
C. Shapland
M. F. Sheehan
Professor R. A. Shooter
D. B. L. Skeggs
Peter L. Skeggs
W. P. Small *V.R.D.*
F. E. Smith *M.B.E.*
J. Forest Smith
Neville Southwell
H. G. Stack
H. B. Stallard *M.B.E.*
W. E. Starkey
Gordon D. Starte
D. D. Steele Perkins *C.V.O. Q.H.S.*
F. J. Stephens
Charles Stuart *O.B.E.*
J. Symmers *V.R.D.*
R. Symmons *V.R.D.*
K. W. Symons

Professor G. W. Taylor
Hermon Taylor
Lionel Taylor
Selwyn Taylor
G. T. Thomas
G. G. Thyne
W. F. Ticehurst
J. S. Tomkinson
F. Trenholm
E. Tulte
T. A. Turnbull
P. S. Turner *Q.H.D.S.*
P. de Turtle *V.R.D.*

Clive Upsohn
C. W. J. Usher

O. J. Vaughan-Jackson *V.R.D.*
H. R. Vickers
G. G. Vickery *O.B.E.*
J. Vinscombe

P. V. Wadsworth
D. K. T. Wallace *M.B.E. V.R.D.*
L. J. Wallace
D. F. Welsh *C.B. O.B.E.*
G. L. Ward *D.S.C. V.R.D.*
T. G. Ward *C.B.E.*
W. R. Ward
B. Waters
A. Macdonald Watson *O.B.E.*
W. F. A. Watson
R. N. H. Whalley
Alan J. Whitaker
Douglas White
K. W. Wilkinson
E. J. Williams
Hugh Willoughby *V.R.D.*
Kenneth Wilson
N. Wiseman
James Wishart
H. R. I. Wolfe, *V.R.D.*
R. Woodside
E. J. S. Woolley *O.B.E. V.R.D.*
Professor Ronald Woolmer *V.R.D.*
G. Wray
P. C. Wrigley
Kenneth Wylie

R. O. Yerbury *C.B.E.*
Alan Young
J. G. Young, *D.S.C. V.R.D.**

A. H. Zair

The Medical Director-General delivered the following speech

My main purpose in speaking tonight is to propose the health of our guests but as most of you know it is our custom to ask them to endure a short patience while I mention to the members of the Club a few of the events of parochial interest during the year I hope they will bear with me

'Our dinner tonight marks the 50th year of the life of this Club Informal annual gatherings of medical officers had been taking place since 1909 but it was in 1912 that the Club in its present form was initiated by Sir James Porter His idea was that it should support certain naval charities but in fact the Club decided to adhere to the adage that charity begins at home It has never supported anything but itself and by this prudent course has remained in a very flourishing state Members may perhaps feel rather sad that they can claim no moral virtue in belonging to it but there can be no doubt of the worldly wisdom of doing so I note that the 1912 dining list contained the names of no less than five future Medical Directors General None of that original list, alas remains with us However starting when it did the Club had only three meetings before the First World War Its continuous existence really dates from 1919 and I am very glad to see that we have one member from the 1919 dinner here tonight Mr Clifford Morson I hope, sir, you will long continue to exercise your membership

"Tomorrow is also the 50th anniversary of the founding of the Royal Naval Medical School, which was opened at Greenwich on 1st May 1912, by Prince Louis of Battenburg I will not tell you more of its history now as it has and will be fully reported in the *Gaffers Gazette* Suffice it to say that it has never been more active than it is now, and, with the start being made on a complete new set of Radio-Biological Laboratories, it is entering on an exciting period of expansion and new activity I am particularly happy to note that the School is enjoying ever closer liaison and co-operation with the other two Services

"I would now like to make a few remarks about our hospitals As you know modernization of Haslar has been going on for some years A Block is the next one due for reconstruction and will provide new medical wards and probably some extra accommodation for women The Chapel is being re-roofed and opportunity is being taken to redecorate it and improve it internally This work, I hope will start in the autumn Plymouth this year celebrates its bi centenary and we are marking this by putting forward a large scheme of modernization to the Board of Admiralty It includes proposals for an Obstetrics and Gynaecology Unit where Service wives and dependants can be treated Since we now look after wives and families abroad I feel it is essential to provide training and experience for our staff by having a Unit in this country The Unit will be planned to contain at least 45 beds, and will comply with the requirements of the Royal College of Obstetricians and Gynaecologists for recognition as a Training Unit

In Malta our plans to take over hospital cover for all three Services are proceeding apace My Civil Assistant and I are flying out on Wednesday to review on the spot the interim arrangements needed during the reconstruction of Mtarfa.

Our most youthful hospital, Mauritius is off to a good start The reports I get suggest it is going to make a really valuable contribution to the life of the Island

I know you will want me to say something about the recruiting situation which has been bad enough in all the Services to attract attention in Parliament and the Press. As far as we are concerned, by the end of this year we shall be between 60 and 80 junior medical officers short of our normal complement. This is a very serious situation. For our part we are trying wholeheartedly to improve both professional opportunities and conditions of service. Pay changes you will have already read about; also of improvements in promotion—in particular—time as a surgeon lieutenant will be reduced to five years, thus bringing the medical officer's seniority more in line with his age. Professionally we are broadening the scope of practice by including more families and by taking National Health Service patients directly into naval hospitals. A scheme has been approved introducing the grade of consultant into the Services. This consultant status is intended to be a realistic one. To attain it, officers will have to show higher qualifications and adequate experience and will have to pass the scrutiny of a civilian selection board.

'Having done what we can to make the career worth while we have to ensure that our efforts are known. To this end individual medical officers and teams of two or three have been visiting medical schools and giving talks about the various types of work they do in the Service. They arrange for groups of senior students and housemen to visit the Portsmouth Command for 48 hours, spending one or two nights at Seafield Park, the home of the Air Medical School. They visit other medical establishments in the area and also spend a day at sea in a frigate or destroyer. This has meant a great deal of extra work for the organizers, and I would wish to thank Surgeon Captain Baskerville and all those who have helped at Haslar, *Dolphin*, the Medical School, and particularly those at the Air Medical School, who bear the brunt of the evening entertainments. Surgeon Lieutenant-Commander Colley is the head of this tourist agency and, judging from the letters I have seen from medical schools, he is doing it remarkably well.

Other schemes which have recently been approved include medical cadetships open to students who have passed their Second M.B. These students can join as acting sub-lieutenants with pay and allowances and would be obliged to serve a five years Short Service commission, receiving a gratuity on termination of their service. In addition the R.N.R. sub-lieutenant entry has been approved and we are arranging for small numbers of senior students to do four to six weeks at naval medical research establishments during the long vacation. This, of course, will include periods at sea whenever possible. We really feel that we have a genuine professional career to offer and that our main problem is to get the young doctor interested in, and informed about, the Navy. Gentlemen, I hope you will all help. Some brochures giving details of the medical branch are available for you to take away tonight.

'I cannot conclude my review without saying a few words about our dental colleagues. Recruitment here also has not been quite as good as it might be and we shall be about half a dozen short by the end of the year. Nevertheless, knowing the reputation of our dental branch in the teaching schools and the profession, I am optimistic that the Royal Navy will continue to attract young dental surgeons. A comparable scheme to that I have mentioned for the Medical Service will also apply to the Dental Service. We have introduced some welcome diversity by recruiting the ladies for Short

Service commissions, and we have now four women dental officers serving. We have been able to get more dental officers to sea in small ships this year and they will doubtless benefit from this experience. Ingenious new equipment enables them to do more useful operative work than ever before.

"Some curiosity was aroused last July by the announcement that Surgeon Rear Admiral Holgate, who had held the appointment as my Deputy for the Dental Services for less than a year, was to retire at his own request. The rumours ended soon when it was announced that the Minister of Health had appointed him to be his Chief Dental Officer for England and Wales. I feel that this appointment was a very great honour to our Service and Admiral Holgate is greatly to be congratulated on it.

"So much for our parochial affairs and I extend my sincere thanks to our guests for the patience with which they have listened to them.

"Our guest of honour tonight is Sir Clifford Jarrett, Permanent Secretary to the Board of Admiralty, and it gives me the greatest personal pleasure to see him here. You members of the Club owe him more than probably most of you realize. The spirit of a chief permeates down throughout his whole department. I am very glad to have this chance of thanking him and all his officers for their understanding and co-operation in the difficult negotiations of the future of the branch and its career structure.

"In addition to Sir Clifford we welcome many distinguished official guests. For brevity's sake I cannot mention them all by name. I have a few special words to say about some, but this is no invidious distinction. I know you will make them feel that we hold them all equal in honour and affection.

"I mentioned earlier our proposed venture into obstetrics and gynaecology at Plymouth. In the planning of this we have received every help and encouragement from the President of the Royal College of Obstetricians and Gynaecologists, Mr. A. C. H. Bell, and we give him the most cordial welcome here tonight. There is a popular opinion that sailors bear a measure of responsibility for a good deal of obstetric activity. Perhaps in the past we have not given enough recognition to this in the medical branch. However, I give notice that the day is now officially past when at the mention of a baby the P.M.O. would shudder and call for a large gin and I look forward to calling on Mr. Bell and his colleagues for still more of their generously given advice.

"I am similarly conscious of obligation to Sir Arthur Porritt, F.R.C.S., to Dr. Godber, Chief Medical Officer of the Ministry of Health, and to Mr. J. A. Drew, the Chairman of the Medical Services Co-ordinating Committee of the Ministry of Defence. Mr. Drew has played so leading a part in obtaining the new rates of pay and improvements in the career structure for medical officers of the Armed Forces and I take this opportunity of thanking him on behalf of my Service; and of course we all owe the most sincere thanks to the President, Captain and Commander of this College. It is through their kindness that we are enabled once again to meet in these historic surroundings.

"I would also like to give a word of welcome and thanks to the D.G.A.M.S., Lieutenant General Knott, and the Secretary of the Central Medical Recruitment Committee, Dr. Grey Turner. The B.M.A. has given every assistance to the Services Medical Directorates and I am very conscious of the debt of gratitude I owe

The last of my special mentions is Air Marshal Sir Patrick Lee Potter whose retirement from the post of D G M S of the Royal Air Force was recently announced Pat was already old and wise in the gamesmanship of Whitehall when I took over and as a new boy I leaned heavily on his skill and experience He has been a great Director We shall all miss him and we wish him a long and happy retirement

To the private guests may I say how cordially we welcome them all I am sorry there are not so many of you as we would have liked To the prospective hosts who were unsuccessful in the ballot all I can do is promise preferential treatment next year

"My Lord and other members of this Club I shall now ask you to rise and drink to our guests

THE BI-CENTENARY OF THE CHURCH OF ST. LUKE, ROYAL HOSPITAL, HASLAR

By The Reverend JULIAN NEWMAN

"The Chapel is now much changed inside, and for the better. It used to be a most dreary place of worship. The three decker pulpit and the high-sided pews were painted white. Above the altar was the inscription over the Cross in Hebrew letters, with a dove over it and yellow rays around. At the other end was a gallery with a grinding organ, which had, if I remember right, a repertoire of some twelve tunes to which Brady and Tate had to be fitted in. The choir was composed of washerwomen, and they were certainly not prima donnas. I have no pleasant recollections of the services. Our chaplain was old and infirm, very long in the sermon, very indistinct and given to reading homilies, which, I regret to say, were conducive of sleep. We consequently often went to Alverstoke."

So wrote a distinguished soldier, Major General J. B. Richardson, the Colonel Commandant of the Royal Artillery. His description is of the Church of St. Luke rather more than a hundred years ago. As he knew the church, so it likely had been since it was built in 1762. It is true that by the 1850s, doubtful embellishments of Victoriana may have intruded themselves. None the less, it makes good reading to know that by 1916 when Major General J. B. Richardson writes, the Chapel is much changed for the better. By that date such stained glass as there is—and none would wax eloquent as to its beauty—was in position.

Bigger changes were soon to come. By 1920 the Cross and "yellow rays around" above the altar were blotted out by a baldachino and a new altar incorporating the old altar stone. The painting by G. Haywood Hardy, R.A., set in new panelling, was set in place as a reredos in December, 1928, and the east end of the Church took on the appearance familiar to those who have used and worshipped in St. Luke's for the last thirty or so years of the two hundred years the Church has been built. In the meantime, the organ which ground its way through Tate and Brady had been replaced by the pleasant toned instrument now in the gallery at the west end. When this took place is not known. (The documentation of the Church, in common with much of the history of Haslar as a whole, is scanty to a degree). We do, however, possess a faded piece of linen-faced paper which proudly proclaims that it "cost £95". Its value today is many times that amount.

From the meagre fund of evidence of the work of the Church in Haslar in the earlier days, the occasional record is of interest. On 22nd February, 1766, the then Chaplain writes a cri-de-cœur for a replenishment of eighteenth century B.Rs.

"Gentlemen,

I beg leave to represent that a Quarto Common Prayer Book is much wanted at the Altar for the use of the Chaplain in administering the Holy Sacrament.

To remove Books from the Desk to the Altar occasionally is both indecent and inconvenient and the size of the Common Prayer Book being a folio interferes very much with a proper consecration of the elements of Bread and Wine

"I am therefore to solicit your influence with the Commissioners of Sick and Hurt for the obtaining this favour, and am Gentlemen,

Your most faithful and obliged humble servant
(Signed) Lewis Boisdaune"

A matter of only three years later he returns to the attack (presumably his earlier plea had been on an unfruitful round of the in-baskets of the Commissioners of Sick and Hurt) and is more demanding of action On 22nd May 1769, he writes

"Gentlemen

I think it necessary to represent to you that the book of Common Prayer appropriated to the desk in the Chapel is in a very dirty lacerated and imperfect condition Part of the Gospel for the Festival of S Simon & S Jude and the whole Collect, Epistle and Gospel for All Saints' are lost

"I am therefore to beg you will please to examine the book and report to the Board accordingly

"I am Gentlemen,
Your obedient and faithful servant
(Signed) Lewis Boisdaune"

A year or so before the Chaplaincy of the eager Lewis Boisdaune there must have been an interregnum when no Chaplain was resident "Curate Collis" of Alverstoke replies more than a little bitterly to a letter from the Commissioners for Sick and Hurt in 1765 querying "whether the Burial Ground Service is constantly read over such of the Patients who have died at this hospital and who were buried in the Burial Ground of this place He counters the query by pointing out that the convenient practice of burying four or even six or eight coffins in one grave which, when filled, could then have the service read over it has been superseded "Now" he writes "in the burying ground at Haslar a mile perhaps distant from Stoke the place of residence of the Minister the order is to dig a single grave for every Seaman that dies in the Hospital and consequently as I apprehend the Minister is expected to go that mile whenever a corpse is brought there in order to read and say the Service over it, and whether it is expected he will go at all times Winter as well as Summer through a dirty road into a bleak field and when the Service performed he may, after being exposed to all kinds of weather return home, and set himself down contented after a journey of two miles and with the pleasing reflexion of his having earned one shilling Whether this be reasonable or not I leave to the judgment of others if not I would hope that Mr Commissioner Maxwell will endeavour to procure such an augmentation of allowance as shall reasonably be thought adequate to the task"

And as a last twist of the knife he signs himself—"Gentlemen with my best wishes for your mutual agreement and happiness, Your most obedient servant

(Signed) Curate Collis"

So much then for the slender glimpses of the past two hundred years that St Luke's has stood But during those two-hundred years unseen enemies have been at work The timbers of the roof structure are dangerously ravaged by the death watch beetle and the floor and much other woodwork by dry rot A survey has revealed that work on reconstruction must begin this year

This construction occurs in the very year of the Two-hundredth Anniversary of the building of the Church The opportunity therefore exists to mark this occasion by seemly restoration and by a particular project With the advice of an expert ecclesiastical architect and also of so well known a lover of eighteenth and nineteenth century building as Mr John Betjeman a general and a particular scheme of restoration has been projected

All structural work and re-decoration (to a preconceived overall design) will be carried out at *Admiralty expense* This will include apart from total re roofing and re flooring with wood blocks, colour washing the walls and 'tidying up' the east end of the Church lowering (to accommodate the organ more readily) and reshaping the gallery removing one staircase to the gallery restoring the moulded ceiling to its original design and fitting of concealed strip lighting

The particular project to commemorate the Two hundredth Anniversary is that a Baptistery should be erected at the ecclesiastical west end of the Church This Baptistery would house a new stone font and cover and would also be embellished by the suggested incorporation of the Haywood Hardy painting as a "wall piece" This is considered by many to be most fitting in such circumstances

The reconstruction and restoration is to be "basic" in the sense that virtually four brick walls only will remain From the shell will be re-created the Georgian building of the Church of St Luke It, therefore behoves us to ensure that every opportunity is taken of simple restoration and beautifying of the Church

The Haslar Church Restoration Fund exists now to provide for such "extras" as the Baptistery The "extras" will it is hoped also include re panelling behind the altar

There are three "roses" in the ceiling of the building The intention is that chandeliers should hang from two of them and a new lamp to burn before the Blessed Sacrament should be suspended from the "rose" before the altar

Seemly re-furnishing of the altar and its ornaments would be consonant with the policy of a complete restoration There is perhaps the possibility that some of these items might be provided as personal memorials

The burden of this article is twofold First the Church of St Luke in Haslar and its history is worthy of presentation and preservation And secondly, to that end, an appeal is made to all who have at heart the interest of religion in the hospital to contribute to the Haslar Church Restoration Fund in this Bi Centenary Year

Reviews

An Introduction to Anaesthetics. By John D. Laycock, M.B., B.S.(Lond.), F.F.A.R.C.S. Pp. vi + 132. London: Lloyd-Luke (Medical Books) Ltd. Price 10s.

Giving anaesthetics is rather like riding a bicycle—a good deal easier as one gains practical experience but it is extremely difficult to teach from a book. In fact a deep knowledge of the mathematics of equilibrium might deter anyone from taking up the art of cycling, in the same way that many textbooks on anaesthesia might well frighten off an intending anaesthetist.

No such charge can be levelled at this thin book, which is paper backed and really pocket-sized. It is written in an easy colloquial style and its subject matter is essentially for students—not only to give them knowledge but confidence as well. There are twelve short chapters, three of the best dealing with preoperative and postoperative treatment and the complications that can arise during the operation.

Throughout the advice is simple, definite and easily remembered. The suggestion that it is the shape of the patient rather than the eminence of the surgeon or the triviality of the operation which should decide whether or not a case can be entrusted to an inexperienced anaesthetist is typical of the extremely practical approach, and not only anaesthetists will appreciate the comment that Old fashioned surgeons and also house surgeons doing their first circumcision always ask if they may start. The others just start.

The book is strongly recommended for students and inexperienced anaesthetists. A. O. C.

Malformations of the Face. By D. Greer Walker, M.A., M.D., M.Ch., D.N.T.Sc., F.D.S.R.C.S. Pp. xii + 202 and 93 illustrations. Edinburgh and London: E. & S. Livingstone, Ltd. Price 37s. 6d. Home postage 2s. 3d.

This fascinating book is divided into four chapters: Variations in the position of the Orbit; The Plasticity of the Craniofacial Structures; An Environmental Hazard of Pregnancy; and the Hazards of Heritage; and attempts to elucidate the Morphological and Genetic problems encountered in such malformations.

The book is well written although the endless catalogue of references in the text tends to add confusion to a subject which is already overburdened with conjecture and at times unjustifiable dogma.

No one can fail to admire the author for his Herculean efforts in referring to the innumerable writers on this subject, and with their varied and at times diametrically opposed views exposing the abysmal ignorance that enshrouds this challenging problem of aetiology.

The anatomical description of deformities is magnificent in its detail and in this respect alone the book should form a useful foundation for any surgeon who attempts corrective measures for these malformations.

With praiseworthy honesty the author states in his book—When anyone takes stock of the whole problem of malformations and sets out what he knows and what is known he must be forced to the conclusion that the time is not yet ripe for great pronouncements on the subject.

This then might be taken as an acceptance of defeat, but any student keen on this subject will find food for thought in this book. It is well to remember that many great discoveries graduated from works in the past which in themselves were far from the truth and yet added links in the chain of progress culminating eventually in final confirmation of ideas.

Is it not possible that if a few more megaton bombs are exploded in the atmosphere the bizarre behaviour of genes may become an unwelcomed reality and our knowledge of morphology will be complete but short lived? E. H. M.

Lectures on the Methodology of Clinical Research. By Max Hamilton, M.D., D.P.M. Pp. vii + 139. London and Edinburgh: E. & S. Livingstone Ltd. Price 21s. Home postage 10d.

The material which the author presents in this relatively small book is of great value to any doctor who considers undertaking any form of research. The early chapters give a sobering account of the fundamental principles involved and the pitfalls to be avoided. Many useful and simple examples are given. It is doubtful, however, whether the uninitiated reader would be able to appreciate the methods of statistical analysis as outlined in the later lectures, though in all fairness it might be agreed that a textbook alone would not achieve this and much patient teaching with the blackboard is necessary.

The book is written in a friendly manner and is easy to read. It is obviously a compromise between lecture notes and a textbook and might have been improved if Doctor Hamilton had written in a slightly less personal way and avoided calling his chapters lectures. Indeed, in his preface he admits that his lectures are not transcriptions of his lecture notes. However, this is a minor criticism of a most useful little book. S. M.

THE FIGHT AGAINST CANCER. By Charles Oberling. Translated by Eric Mosbacher. Introduction by Sir Cecil Wakeley Bt. Pp. 164. London: Andre Deutsch Ltd. Price 18s.

The title and the attractive dust cover of this book may themselves sell a number of copies and the readers will not be disappointed at the contents though on the whole it is a book which is likely to be most appreciated by medical men in spite of a somewhat inadequate glossary which suggests the author is hoping for non-medical readers also.

The whole complicated and puzzling background of the origin and development of cancer in all its forms is admirably covered. Early theories as far back as Galen are fairly discussed and placed in scientific perspective. The present thoughts which include radiation, parasitization, heredity, physical and chemical irritations and finally virus infection are all thoroughly considered.

The outstanding feature of the book is the emphasis which it places on the complexity of the problem and in the final chapters the reader is still uncertain as to the cause of cancer but is given convincing evidence that although the many factors described play their parts the virus seems to be the number one suspect and because of this considerable effort is made to introduce the more important characteristics of the virus itself. No better summary can be given than to quote one small paragraph from the penultimate chapter: "Today we regard the virus as a foreign gene complex which invades the cell, subjects the metabolism of the latter to its own influence and thus removes it from the control of the organism. By this process the cell, unless it rapidly perishes, automatically turns into a cancer cell."

Finally it must be remembered that the book is a translation and as such it has possibly lost some of its original force for though the translation is obviously accurate the personality of the author is not apparent. The book is, however, excellent value for the moderate price of 18/-. S. M.

ESSENTIALS OF CARDIOLOGY. By S. G. Owen, M.D.(Durh.), M.R.C.P.(Lond.) and J. Vallance-Owen, M.D.(Camb.), M.R.C.P.(Lond.). Pp. v + 215. London: Lloyd-Luke (Medical Books) Ltd. Price 25s.

Since Sir Thomas Lewis's classic *Diseases of the Heart* was last published there has been a need for a textbook of cardiology written primarily for the student. Such a book must contain the essential facts in brief but readable form and be reasonably priced. Generally speaking this volume fulfils the requirements and the authors are to be congratulated for their initiative.

The book comprises four sections. PART I: PHYSICAL EXAMINATION: THE SIGNS OF HEART DISEASE, describes the signs of heart disease in order of their observation during physical examination. PART II: SPECIAL INVESTIGATIONS gives a full account of electrocardiography and the radiology of the heart. More recent techniques are adequately dealt with. PART III: GENERAL SYNDROMES AND TREATMENT includes chapters on heart failure, the arrythmias and the pharmacology and use of drugs. PART IV: THE VARIETIES OF HEART DISEASE deals with the clinical features and treatment of the various forms of heart disease classified according to aetiology. The authors rightly consider that the repetition consequent upon such an approach is desirable and have not resorted to the use of tedious cross references.

Unfortunately Part I lacks the clarity of later Sections. One does not have the impression as the authors intend that a systematic examination of a patient is being performed. More line diagrams and summaries to supplement the text, particularly in the Sections on the pulse and ventricular enlargement, would be an improvement. A discussion of the pulmonary signs of heart disease is an obvious omission. Part II, particularly the chapter on electrocardiography, is excellent and should please the student who wishes to delve more deeply into the subject than the final examination requires. A more definite schedule for digitalis administration is desirable; otherwise Parts III and IV are very good. A chapter on the normal anatomy and physiology of the heart would be a welcome addition. The Index is adequate.

The book in its present form can be confidently recommended to students and practitioners. It is to be hoped that further improved editions will appear. E. N. O'B.

A HANDBOOK FOR AMBULANCE ROOM ATTENDANTS. By C. E. Watson, M.A., M.B., B.Chir., M.R.C.S., L.R.C.P. Pp. 128. Illustrated. London: Baillière Tindall & Cox Ltd. Price 5s. 6d. + 9d. home postage.

This unpretentious little handbook, produced primarily for industrial ambulance room attendants, is intended to supply more advanced knowledge to those who have had no training beyond the conventional course in First Aid and who, in some circumstances, may have to take complete charge of a patient without recourse to qualified medical help.

Within these limits the author has attained his object and has succeeded admirably in producing an interesting and well written book.

The thirteen chapters include sections on infection, haemorrhage, burns, diseases of the skin, abdominal pain and the assessment and disposal of cases of illness.

In the chapter on asphyxia and artificial respiration many medical authorities will disagree with the author's statement that the best methods of artificial respiration to use are Holger Neilsen's, Sylvester's, Drinker's and Eve's Rocking Stretcher, whilst he reserves the mouth to mouth insufflation method for occasions when none of these can be used.

There is a printer's error in the glossary on page 107 where the formula for carbon monoxide is described as CO_2.

The price is very reasonable and many will welcome the opportunity to read this book but, owing to its limited scope, it will be of doubtful value to the Naval Medical Service. M. F. S.

MODERN TREATMENT YEAR BOOK, 1962. Edited by Sir Cecil Wakeley, Bt., *K.B.E., C.B.*, LL.D., D.C.L., D.Sc., F.R.C.S., F.R.S.E., F.R.S.A., F.A.C.S., F.R.A.C.S. Pp. ix+306, with black and white photographs. London: Baillière, Tindall & Cox Ltd. Price 35s. Postage 2s. 3d.

For nearly thirty years the Modern Treatment Year Book has been specially compiled to keep busy practitioners informed on the latest therapeutic methods and practical applications of the latest research.

The 1962 volume covers a wide variety of topics, giving up to date diagnosis and treatment of many conditions which may be encountered in daily general practice. The contributors are all expert in the subjects about which they write and the fruits of their experience are placed before the reader in a concise, practical and easily assimilated form. In effect this book is a refresher-course in practical therapeutics.

There are twenty nine separate articles with twenty four pages of plates and many other illustrations. The subjects covered include emergencies and acute and chronic complaints in the realms of general and orthopaedic surgery, otorhinolaryngology, urology, gynaecology, general medicine, psychiatry and geriatric medicine.

The Year Book offers a palatable means of keeping up to date. Those general practitioners who aspire to succeed in their task will regard this volume as essential reading and as a useful book of reference. L. D. A.

HOME TREATMENT IN INJURY AND OSTEOARTHRITIS. By W. E. Tucker, *C.V.O., M.B.E.*, T.D., M.A., M.B., B.Ch., F.R.C.S. Pp. viii+80. Many illustrations. Edinburgh and London: E. & S. Livingstone Ltd. Price 10s. 6d. +9d. postage.

This is a concise, easily read monograph for the practitioner and his patient, setting out the elements of home care for the orthopaedic patient. It is not so much a "Do-it Yourself" book of physiotherapy as an example of applied commonsense and a guide to exercises and activities which can complement formal physiotherapy or help the patient who cannot reach a department for after care or who is a chronic sufferer from degenerative arthritis.

The first part of the book is for the doctor and the rest gives examples of the home care leaflets which Mr. Tucker provides for his patients.

The text is most clearly laid out and provides exercise routines illustrated by line drawings of a high standard. Emphasis is on posture, gradation of activity and avoidance of fatigue.

In general no specialised apparatus is used although the use of radiant heat lamps and wax baths in the home are included. With the co-operative patient this practice has endless possibilities and may well be the means of salvation of many over-crowded and over worked physiotherapy departments.

For ships' doctors this is a most valuable guide to the rehabilitation of minor orthopaedic patients without special facilities.

A doctor or patient can obtain Part II separately or any number of individual leaflets. K. T. H.

We acknowledge with thanks receipt of the following publications.

Acta medica et Biologica. Annales Medicinae Internae Fenniae. Annali di Medicina Navale. Australian Journal of Experimental Biology. British Journal of Surgery. British Medical Bulletin. British Medical Journal. B.S.I. News. Bulletin of the World Health Organization. Fukushima Journal of Medical Science. Guy's Hospital Gazette. International Review of the Army, Navy and Air Force Medical Services. Journal of the Royal Army Medical Corps. Journal of the Royal Naval Scientific Service. Kyushu Journal of Medical Science. Medical Digest. Medical Journal of Osaka University. Middlesex Hospital Gazette. Military Medicine. Montreal Medical. Nauk Review. Nagoya Journal of Medical Science. Proceedings of the Staff Meetings of The Mayo Clinic. Research and Reviews Bowman Gray School of Medicine. Revista Do Instituto De Medicina Tropical De Sao Paulo. Smokes Alive. Sotilaslaaketieteen Aikakauslehti. St. Mary's Hospital Gazette. St. Thomas's Hospital Gazette. The Broadway. The Kurume Medical Journal. Tohoku Journal of Experimental Medicine. The Journal of the Irish Medical Association. Tropical Diseases Bulletin. University of Durham Medical Gazette. Ulster Medical Journal. Wakayama Medical Reports. Yokohama Medical Bulletin. Yonago Acta Medica.

News of the Service

OBITUARY

Lambert Charles ROGERS *C.B.E.* V.R.D. M.Sc. M.D. M.Ch. F.R.C.S. F.R.C.S.[illegible] F.R.A.C.S. F.A.C.S. (1897–1961)

Lambert Rogers will be missed by a large number of medical officers of the Royal Navy and Royal Naval Reserve who knew him and worked with him during the war. He w[illegible] and ships and had been an enthusiastic member of the R.N.V.R. having served as Surgeon Probationer in the First World War. In the Second World War he came back as a Surgeon Captain and Consultant Surgeon having temporarily vacated the Chair of Surgery at the University of Wales. The Royal Naval Auxiliary Hospital at Barrow Gurney was the base from which several of the naval consultants including Lambert worked and it was most interesting and instructive to be attached to such an organization, one of the unwritten laws being that every medical officer while serving in the hospital should prepare himself for some higher degree or diploma. In the quiet Somerset atmosphere surrounded by a group of helpful medical and surgical celebrities conditions were ideal for this purpose and Lambert was an inspiration and a tower of strength. It is unnecessary to dwell upon his many distinctions and his professional achievements except to record that his kindliness of nature was only matched by the beauty of his surgical technique. He made up his mind quickly and acted with prompt[illegible] qualities to which many who sustained injuries to the brain and spinal cord owe their lives and health today. Deeply religious, he was none the less socially minded with a remarkable knowledge of clubs, restaurants and places of entertainment, especially apparent when we had occasion to go together to Australia. Lambert never failed to acknowledge his gratitude to his teachers. He had been house surgeon to Sir John Bland Sutton and had the closest association with George Grey Turner and Sir Gordon Gordon Taylor, all of whom he regarded with great deference and affection, but Lambert was a great surgeon in his own right and part of the immortality of his leaders and mentors is amply expressed in his own character and achievements. Lambert did not marry until he was in his fifties. His marriage was an idyll of happiness, and the arrival of a daughter soon showed that the duties of a father were among the tasks which he could perform with great tenderness and thoroughness. Of his activities which I deeply regret having missed were the little services which he held in the Children's Ward at the Cardiff Royal Infirmary on a Sunday morning.

Of all the honours which fell to Lambert probably the one which warmed him most was the Honorary Doctorate of Medicine from the University of Melbourne conferred during his honeymoon trip to Australasia. Although extremely proud of the dignity of his University Chair he had a great aversion to the spoken or written prefix of "Professor", much preferring the title "Doctor", which his friends were most careful to use. An insistence on absolute punctuality which Lambert imposed as a bachelor happily became relaxed after his marriage, but he still insisted on the superiority of the pre 1939 Rolls Royce car to all subsequent models.

We miss him deeply and join with his wife and little daughter in their great loss, but look back with great satisfaction in having been privileged to know him well and to have observed a character of unusual gifts of intellect and of great moral integrity. D. P. GURD

Surgeon Rear Admiral T. MADILL *C.B. O.B.E.* M.B. B.Ch. died on 10th February 1962 at the age of 67.

He was born at Garvagh, County Londonderry, on 14th January 1895 and graduated M.B. B.Ch. Trinity College, Dublin, in December 1919. For some months before the end of the First World War he served as a Surgeon Probationer R.N.V.R. in ships of the Harwich Flotilla. After resident appointments at Sir Patrick Dun's Hospital, Dublin, he entered the Royal Navy.

His early years in the Service were spent in H.M.S. *Clematis* on Red Sea Patrol, H.M.S. *Bee*, Yangtze Flagship, and with the Royal Marines, Portsmouth. Later he took up radiology as a speciality and served at the Royal Naval Hospitals, Chatham and Haslar. He was awarded the *O.B.E.* in the Birthday Honours of 1941. In July 1942, while in charge of the Patrol Service Depot and Sick Quarters at Lowestoft, he held the acting rank of Surgeon Captain and later, in January 1944, he was confirmed in that rank. In May 1943 he was appointed as Staff Medical Officer to the Deputy Naval Commander of the Expeditionary Force at the time of the Allied landings in Sicily. As Staff Medical Officer to the British C.-in-C. Germany he was responsible for the naval medical arrangements for Germany on the conclusion of the Second World War. On his return to the United Kingdom in 1946 he was appointed to the Medical Department of the Admiralty as Assistant to the Medical Director General and, at this time, when the run down of large numbers of temporary war time medical officers was taking place, his qualities of patience and consideration were exercised to the full. He was appointed as Medical Officer in Charge of the Royal Naval Hospital, Malta, and Fleet Medical Officer to the C.-in-C. Mediterranean, and promoted Surgeon Rear Admiral in July 1950. In the following September he was appointed K.H.P. and was later reappointed as Q.H.P.

In 1950 the King sanctioned Surgeon Rear Admiral Madill's appointment to the Venerable Order of St John of Jerusalem as Commander (Brother). In the Birthday Honours of 1952 he was awarded the *C.B.* He retired from the Navy in November 1953.

To Tom Madill, as his colleagues will best remember him, the Navy was his life. The keen interest of his years of active service was maintained during his all too short period of retirement, which he spent in Southsea among his wide circle of friends. He married Mary, sister of the present Medical Director General of the Navy, Surgeon Vice Admiral W. R. S. Pennefather, *C.B.*, Q.H.P., in August, 1930—to Mrs. Madill and to their son Michael, who survive him, we extend our sympathy.

Surgeon Rear Admiral L. F. STRUGNELL, *C.B.*, M.B., B.S., M.R.C.S., L.R.C.P., died on 3rd February, 1962, at the age of 69.

He was born in London on 1st October, 1892, and received his medical education at St. Bartholomew's Hospital. He entered the Royal Navy as a Temporary Surgeon Lieutenant in January 1915, immediately after taking the Conjoint Diplomas. He graduated M.B., B.S., London University in July, 1921. During the First World War he served in H.M. Ships *Carmania*, *Magpie* and *Queen* and was mentioned in despatches while serving in the latter ship. He entered the permanent service of the Royal Navy in November, 1918. In 1925, while serving in the Royal Naval Hospital, Plymouth, he was awarded the Gilbert Blane Medal. For a time between the wars he practised ophthalmology, and the outbreak of the Second World War found him in H.M.S. *Barham* as Squadron Medical Officer to the First Battle Squadron in the Mediterranean. He was promoted to the rank of Surgeon Captain in July, 1941, and in 1944 was appointed Medical Officer-in-Charge of H.M. Hospital Ship *Vita* with the Eastern Fleet. Later he became Fleet Medical Officer, East Indies Station. In December, 1947, he was promoted Surgeon Rear Admiral and appointed to the Admiralty as Deputy Medical Director General. In July, 1947, he was appointed an Officer (Brother) of the Venerable Order of St. John of Jerusalem. In March, 1948, he was appointed King's Honorary Physician and his abilities were recognized by the award of the *C.B.* in the New Year's Honours, 1949. He retired from the Service in November, 1951, and made his home in Hayling Island, Hants.

Surgeon Commander A. G. BEE died on the 4th January, 1962, at the age of 71.

He qualified L.R.C.P. and L.R.C.S.(Edin.) and L.R.F.P.S.(Glas.) and entered the Royal Naval Medical Service on the 17th July, 1917, as a Surgeon Lieutenant. He was promoted Surgeon Lieutenant-Commander on 21st September, 1925, and to Surgeon Commander on 21st September, 1931. He was placed on the Retired List on 30th November, 1937.

Miss Mildred LLOYD HUGHES, R.R.C. and Bar, died on 5th January, 1962, at the age of 83. She entered the Q.A.R.N.N.S. on 28th December, 1908, at Royal Naval Hospital, Haslar. She also served in the naval hospitals at Plymouth, Chatham and Gibraltar and at Osborne House.

In 1911 she was one of the first eight sisters to be promoted to the new rank of Superintending Sister and became a Head Sister in 1916.

In 1929 she succeeded Miss Keenan as Matron-in-Chief, combining the position with that of Head Sister at R.N. Hospital, Chatham, eventually retiring in 1934.

Miss M. C. Clark, Head Sister, retired, writes of her:

Miss M. Lloyd Hughes will have been remembered by all Ranks and Ratings who served under her with great affection and very treasured memory and respect.

She was a disciplinarian and had a very loyal sense of duty. She handled difficult situations either with persons or problems with tact and sympathetic understanding and with her great sense of humour endeared herself to all.

HONOURS AND AWARDS

Queen's Honorary Physician

Surgeon Captain A. E. Flannery, *O.B.E.*, L.R.C.P. & S.

HIGHER QUALIFICATIONS

F.R.C.S.(Eng.)	Surgeon Lieutenant J. W. Richardson
F.F.A.	Surgeon Lieutenant-Commander J. Haughton
M.R.C.P.(Edin.)	Surgeon Lieutenant Commander O. O. R. McCarthy
D.C.P.	Surgeon Commander D. O. Haines
D.P.H.	Surgeon Lieutenant-Commander K. J. McLean
D.P.H.	Surgeon Lieutenant-Commander F. J. O'Kelly
D.M.R.D.	Surgeon Commander R. S. MacDonald
D.O.	Surgeon Commander T. S. Law
D.O.	Surgeon Lieutenant A. J. Rimoul
D.O.	Surgeon Lieutenant M. G. Williams
D.R.C.O.G.	Surgeon Lieutenant Commander M. C. H. Jackson

PROMOTIONS

To Surgeon Captain—J F Meynell, M R.C S, L R C P, D A, J W Walker *O B E* M B Ch B, J F Wellwood M B B Ch, M F Sheehan M B B Ch
To Surgeon Captain (D)—K E J Fletcher L D S
To Surgeon Commander—E H P Warburton M R C S L R C P, F C S Pearson M B Ch B, D P M, R H B Broughton M D Ch B, M R C S L R C P
To Surgeon Commander (D)—G J Boyd F D S, M E P Easton L D S
To Surgeon Lieutenant Commander—M K Mead M B B Ch
To Surgeon Lieutenant Commander (D)—J M Popplewell L D S, B M Harris, L D S, C T Stacey L D S

RE ENTRIES

Surgeon Lieutenant Commander K J Martin M D (Cantab) B Ch
Surgeon Lieutenant J P Gill M B B.Ch

NEW ENTRY

A/Surgeon Lieutenant G D Lister M B Ch B

TRANSFERRED TO PERMANENT LIST

Surgeon Lieutenant C W Chapman, M.B Ch B

RETIREMENTS

Surgeon Rear Admiral W P E McIntyre *C B* Q H P M D B Ch (Age) 5 1 62.
Surgeon Captain T L Cleave M R C P (Lond) (Own request) 13 2 62
Surgeon Commander R E Lander, M R C S L R C P (Age) 25 3 62.

WARDMASTERS

PROMOTIONS

S B C P O T Montgomery—to Acting Wardmaster Sub Lieutenant 1 3 62.
S B P O J R Wyburn—to Acting Wardmaster Sub-Lieutenant 31 1 62

RETIREMENTS

Wardmaster Lieutenant Commander F V Moth (Age) 13 4 62
Wardmaster Sub-Lieutenant M H Richards (Age) 2.2 62.

QUEEN ALEXANDRA'S ROYAL NAVAL NURSING SERVICE

PROMOTIONS

To Matron in Chief—Miss J M Woodgate, R.R C 14 7 62
To Matron Tutor—Miss B Quill 18 6 62
To Superintending Sister/Matron—Miss C Thompson A R R C 17 4 62
To Superintending Sister/Matron—Miss A. M Guild 1 5 62.

RETIREMENTS

Principal Matron—Miss S K E Richards R R C (Own request) 15 6 62
Superintending Sister—Miss M M. Gilbough A R R C. (Own request) 30 4 62

ROYAL NAVAL RESERVE

PROMOTIONS

To Lieutenant-Commander—J L Price, M B B S R E Draper M B B S D R C O G

APOLOGY

It has been brought to the notice of the Editor that in recent issues of the JOURNAL the lists for Honours and Awards Promotions etc have been incomplete This is regretted and the Editor wishes to express a formal apology to those whose names have been inadvertently omitted Steps have been taken to ensure as far as possible that no further omissions will occur

JOURNAL OF THE ROYAL NAVAL MEDICAL SERVICE

ANNUAL REPORT, 1961

Balance Sheet

ASSETS	£ s. d.	LIABILITIES	£ s. d.
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Cash	2 1 2		
		Managerial Expenses	11 10 0
£600 of War Loan 3½ per cent	311 12 6		
		Publication Costs	183 4 0
£100 of Funding Stock 3 per cent	82 10 0		
		Reprints	67 0 0
Deposit Account	532 18 4		
			£276 16 3
Reprints	83 0 0		
Advertisements (Autumn 1961)	83 0 6	Balance Creditor ...	1,182 7 0
	£1,459 3 3		£1,459 3 3

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F. W. MITCHELL,
Wardmaster Lieutenant.

ADMIRALTY FLEET ORDERS

(This page is perforated for filing purposes)

1666/61—Surgeons and Agents.

1682/61—Medical—Blood Transfusion Unit.

1962/61—Gilbert Blane Medal—Award for 1961.

2010/61—Medical—Arrangements in U.K. for Medical Treatment whilst on leave or on appointment where Service Medical Facilities are NOT available.

2018/61—Uniform, Q.A.R.N.N.S.—Naval Nursing Auxiliary Section.

2054/61—Medical R.N. Bulletin No. 12. Distribution.

2115/61—Medical—Eyesight—Spectacles.

2176/61—Medical—Patient Evacuation Tag—Introduction.

2273/61—Suppressive Treatment of Malaria.

2405/61—Workpeople—General—Recording of Accidents in Accident Book B1510A.

2447/61—Forms—Dental Officer's Official Diary, Form S.1. (Code No. 6-1-2).

2459/61—Accidents—Dangers of Handling Electrical Equipment—Need for Immediate Artificial Respiration in Event of Apparent Death by Electric Shock.

2523/61—Officers—Medical and Dental—Gratuities.

2556/61—Admiralty Surgeons and Agents.

2593/61—Safety Harness for Transport Stretchers.

7/62—Courses—Officers—Radiological Defence, Underwater Medicine and Survival, and Tropical Medicine, 1962.

59/62—Courses—Diving—Medical Documents.

101/62—Regulations for Protection of Personnel Exposed to Ionising Radiation from Radioactive Materials, X ray Apparatus and other Electronic Devices.

102/62—Radiation Hazards—Maximum Permissible Levels of Exposure to Ionising Radiation.

103/62—Radiation Hazards—Symbol Indicating the Presence of Ionising Radiation or Radioactive Material.

Notice

The Editor invites medical officers to send in original papers on professional subjects travel, personal experiences etc Items of news and matters of interest to the naval medical service will be welcomed from ships and establishments on home and foreign station Notices of births, marriages and deaths are inserted free of charge to subscribers

All articles or communications published in the Journal of the Royal Naval Medical Service will become the property of the Journal with full copyright powers unless the author declares when sending in the article that he desires to reserve the copyright to himself

The Harvard system should be employed for bibliographical references these references being arranged in alphabetical order of the authors names at the end of the contribution thus Smith F G (1935) *J roy nav med Serv* **22**, 53 In the text a reference to a publication should be cited by giving the author and in brackets the date, thus "Smith (1935) believed this to be due etc" or " lack of basis information on the strategic fundamentals of the science of the sea (Carson, 1956)"

The Journal is published quarterly, four numbers comprising one volume

Articles and communications may be sent to the Editor at any time **They should be clearly written or, preferably, typed and sent in duplicate to The Editor, R N Medical School Alverstoke, Hants**

Subscriptions

For R N and R N R medical personnel on the active or retired list and for Consultants to the Royal Navy the subscription is 20s per annum (postage included) payable on 1st January of each year Single copies 5s

For dental officers in the above categories the subscription is 10s per annum (postage included) Single copies 5s

For all others who are *not* in the above categories the subscription is 24s per annum (postage included), or 6s per single copy

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THE EDITOR

Journal of the Royal Naval Medical Service

R N Medical School, Alverstoke Hants

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No 3 Summer 1962 Vol XLVIII

Journal
of the
Royal Naval Medical Service

PUBLISHED QUARTERLY
(*The Admiralty does not accept responsibility for the opinions expressed in this Journal*)

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EDITED BY
THE STAFF OF THE ROYAL NAVAL MEDICAL SCHOOL
ALVERSTOKE HAMPSHIRE

Editorial

It is indeed [illegible] that the Journal indulges in the luxury of [illegible] although recognizing their extreme value in illustrating medical [illegible] due to the generosity of Professor Davies and Doctor Campbell [illegible] Oceanographic Research Unit, Durban that we have been able to include the two colour plates [illegible] their exceptionally fine article on shark attack So many wild and varied stories of the hazards of sharks are encountered that it is extremely valuable to have available such a comprehensive and unemotional account of this subject as appears in the following pages The area of the world s seas where sharks are active stretches round the globe and is extensively used by Her Majesty s Ships It is therefore desirable that medical officers should be fully aware of the problem and although much has been said and written elsewhere it would be hard to find a more useful account than that we have received from our friends in South Africa

It is fitting too that this number should contain the concluding chapters of Surgeon Commander Glass s Treatise on Marine Science, which emphasizes the growing interest of the naval medical officer of today in subjects on the fringe of medicine Just as a doctor ashore may frequently interest himself in the plant and animal life around him so might those who have the good fortune to serve afloat become acquainted with the living things beneath them

Lest those amongst our readers who look to this JOURNAL for clinical papers feel they have been neglected let them be reassured that in the next issue they will see the first of a short series of papers on Ageing in the Royal Navy and a historical review of the development of the various techniques of resuscitation

Suggestions for improving the JOURNAL as well as original articles are always welcomed by the Editor and recently the question has been raised as to whether our columns should be opened to correspondence on current problems affecting the Royal Naval Medical Service In a JOURNAL which is only issued four times a year it is not easy to maintain a continuous flow of correspondence on any particular subject Nevertheless letters will be published if the subject matter is of general interest to the readers It would be a mistake however to run the risk of becoming parochial in outlook and therefore some selection may be necessary The JOURNAL has a wide distribution outside the Service and holds a position of esteem amongst its contemporaries for the high standard of its professional papers In these days when many people are writing there is often considerable delay in publication in the more widely produced journals The *Journal of the Royal Naval Medical Service* is however primarily the mouthpiece of the Naval Medical Service and the policy will be continued where contributions from outside and inside the Service receive equal consideration

A recent appeal for additional subscribers to the JOURNAL amongst serving medical officers has received very satisfactory and welcome response What has been surprising is the large number who have not been aware of the JOURNAL S existence This typical naval modesty is no doubt a virtue but the wider the circulation the more funds become available to increase its stature Anything which readers can do to increase the circulation would therefore be most welcome

Articles

THE AETIOLOGY, CLINICAL PATHOLOGY AND TREATMENT OF SHARK ATTACK

(Based on observations in Natal, South Africa)

By Professor **DAVID H. DAVIES, M.Sc., Ph.D.**
*Director, Oceanographic Research Institute, Durban
and Research Professor, The University of Natal*

and

Doctor G. D. CAMPBELL, M.B., M.R.C.P.(Edin.)
*Research Associate, Oceanographic Research Institute, Durban
and Assistant Physician, The Department of Medicine, University of Natal*

I. Aetiology

(A) *General.* Man has long since mastered the largest and fiercest of land animals but the general reaction to shark attack shows that sharks are among the few remaining creatures capable of instilling terror into the hearts of humans and that man has not yet devised any satisfactory means of protecting himself from sharks.

Examination of the records of shark attack throughout the world suggests that from a statistical point of view the problem is hardly worth worrying about. There are certain factors, however, that cause the incidence of shark attack to be given far greater prominence than it rightly deserves. One of these factors is related to the fact that the human population of the world is increasing at an alarming rate, the leisure time of most people is increasing and more and more use is being made of the sea as a recreational outlet. This, coupled with efficient and rapid news coverage throughout the world, has brought the phenomenon of shark attack into almost every household.

Although the injuries sustained in shark attack are nearly always serious and frequently fatal, similar or worse injuries are sustained almost daily as a result of traffic accidents. The latter are, however, accepted quite philosophically while a single shark attack in the same community creates a sensation and results in almost hysterical outbursts demanding that "something should be done immediately." In areas where the economy is dependent on tourism, serious repercussions may be felt due to the early departure of the visitors and the cancellation of future reservations.

The problem of shark attack on humans is therefore a serious one in peacetime and is even more serious during time of war when the chances of humans landing in the sea far offshore are so greatly increased. In an attempt to present the problem in its right perspective, it should be borne in mind that there are well over three hundred different species of sharks known but of these less than twenty species have been proved dangerous to man. Shark attacks occur throughout the year between latitudes 0–20° N. and S. and tend to occur mainly in the summer months between 20–40° N. and S. Although records of attack seem to indicate a definite relation to water

[illegible] that the majority of attacks occur [illegible] in [illegible] water There is no doubt that the [illegible] peculiar to the particular area in which they occur and [illegible] those of another [illegible] For this reason it is considered [illegible] every aspect of the problem should be conducted in each [illegible] occurs

In the U S A the Shark Research Panel of the American Institute of Biological Sciences was formed in 1958 under the Chairmanship of Dr Perry W Gilbert (Gilbert 1960) The panel has been responsible for the initiation of a great deal of research on shark attack and on many aspects of elasmobranch ichthyology Serving on the Panel with Dr Gilbert are Dr Leonard P Schultz and Mr Stewart Springer Each member is actively engaged in one or another aspect of shark research and Dr Schultz is keeping a Shark Attack File for the entire world (Schultz 1958) A shark research programme is also being conducted in the Pacific by Dr Albert Tester of the University of Hawaii (Tester 1961) which together with Dr Gilbert's programme in the Bahamas provides excellent coverage in the Pacific and Atlantic Oceans A shark research programme has been conducted at the Oceanographic Research Institute in Durban since 1959 and provides coverage for the Indian Ocean (Davies 1960 a) Australia is one of the worst affected areas and it is hoped that an active shark research programme will be started there in the near future The importance of active research on the problem of shark attack in each of the various affected areas cannot be sufficiently emphasized since the circumstances conditions species of shark and other factors are likely to differ widely in relation to each area concerned

(B) *South Africa* The incidence of shark attack off the east coast of the Republic of South Africa is high Since 1940 there have been fifty-seven attacks of which twenty four were fatal (February 1962) and during the last five years there have been eighteen attacks and a further three attacks in 1961 at Xai Xai in Portuguese East Africa (see Fig 1)

The area most seriously affected in South Africa is the Natal south coast (see Fig 2) a resort area consisting of approximately one hundred miles of coastline Shark attack has already had an extremely adverse economic effect on the area and the problem of the protection of bathers has now become acute Active steps to prevent shark attack have been taken by many local authorities along the south coast These usually take the form of enclosures or mechanical barriers erected in the sea which provide a protected area in which bathers may swim without fear of attack As an immediate protective measure such enclosures have considerable value but they are nevertheless subject to many disadvantages Most barriers are costly and unsightly They are subject to wave damage corrosion and may be unreliable due to the presence of holes beneath the surface which can only be detected by regular underwater inspection Barriers of this kind whether intact or damaged present dangerous hazards to swimmers divers and small craft

The beaches adjoining the metropolitan area of Durban extend over a distance of approximately two miles Between 1944 and 1951 twenty attacks took place in this area In 1952 the city authorities installed a system of gill meshing or set-nets off the

Fig. 1 The Republic of South Africa

Fig. 2 Natal South Coast

Durban beaches on the [illegible] as those used [illegible] the Australian beaches (Davies, 1961 [illegible]). No attack has occurred [illegible] of these nets (February 1962). [illegible] of this system [illegible] firstly the nets appear to have the effect of reducing [illegible] (the total catch for 1952 was 55[illegible] sharks with [illegible] the number caught down to 121 sharks in 1961). This [illegible] out the experience of many shark fisheries in various parts of the world that a reduction of the shark population may take place as a result of intensive [illegible]. The second factor in the success of this method is thought to be linked with the [illegible] discomfort that most large sharks experience when any sort of barrier lies between them and the open sea. The application of this method along the entire south coast would be difficult due to the conformation of the coast, the absence of suitable harbours for vessels to service the nets, and the high costs involved for such an extended area. In addition, the set-net system, although very good, is not infallible, as is shown in Australia where three attacks have occurred in areas protected by nets. The situation off the east coast of South Africa is therefore that there is a problem caused by the presence of sharks in inshore areas which is in need of urgent solution and, although interim measures such as set-nets and barriers have to some extent alleviated the situation, no final answer to the problem has so far been found.

A programme of research on sharks with special reference to shark attack on humans was begun by the Oceanographic Research Institute in Durban in 1959. The approach to the problem has been on the broadest possible basis and the various aspects being investigated include the following:

(a) a survey of the sharks of the east coast region (for the purpose of accurate identification of the sharks in the area and the determination of the species dangerous to man)

(b) an investigation into the bacteria present in sharks' mouths (with a view to establishing their pathogenicity to man)

(c) the keeping of sharks in captivity and behavioural studies (with a view to learning about the habits of sharks dangerous to man)

(d) studies of the wounds of victims of shark attack and the circumstances surrounding attack (for the purpose of determining the species of sharks responsible and the factors involved in shark attack)

(e) examination of methods of emergency treatment of victims of shark attack (for the purpose of the establishment of an efficient system of emergency treatment along the entire coast in affected areas)

(f) experiments with chemical repellants and electrical, sonic and compressed air barriers (for the purpose of devising a system of protection for bathers)

(C) *Factors affecting shark attack in South Africa*. The factors affecting the predaceous behaviour of sharks with reference to humans seem to be both numerous and complex and the separation and assessment of their relative importance is no easy matter. A paper was read on the subject at the Xth Pacific Science Congress (Davies 1961 b).

Eight cases of shark attack have been investigated by the Oceanographic Research Institute since 1959 off the east coast of the Republic of South Africa, including one

[illegible] in addition [illegible] [illegible] As a result of the [illegible] it appears that certain factors have [illegible] in relation to shark attack in this area

Among the factors investigated were water turbidity temperature salinity depth distance from shore geomorphology of the beaches and sea-floor condition of the sky colour of the victim's costume colour of the victim's skin presence or absence of jewellery date and time of attack state of tide and the possible effects of offshore whaling and the discharge of sewage and industrial effluent into the ocean While at this time there is insufficient data for a final analysis of the significance of these factors to be possible it may be of interest to record progress in this respect and to provide an indication of which of these factors appear to be important at this stage

(a) *Turbidity* records for nine out of eleven cases have been based on observation and serve to differentiate only between clear water and dirty water In the two most recent cases water samples were taken and the degree of turbidity was determined more accurately by measuring the optical density The records indicate that in nine out of eleven cases the water was dirty i e it contained suspended particles the origin of which was almost certainly from flood water from nearby rivers

It is considered that turbidity and extensive discolouration of the sea along the coast even if only based on observation is indicative of the presence of flood water from rivers and it is probable that sharks are attracted to flooded areas due to the likelihood of finding food organisms there In addition the presence of fresh water as indicated by the discolouration of the sea is regarded as being of considerable importance in relation to the species of shark (*Carcharinus zambezensis*) which is believed to be principally responsible for attacks in this area

(b) *Temperatures* ranged from 21 4 C (70 5 F) to 27 8 C (82 0 F) in the nine cases for which temperature records were obtained In four cases the temperature was over 26 °C

Winds from the north and north east drive warm oceanic water close inshore along the Natal coast and in addition spread silt-laden fresh water from the rivers parallel to the coast Observations of living sharks at the Oceanographic Research Institute indicate that the predatory activities of sharks increase as a result of sudden changes in temperature (irrespective of the direction of change) and in addition, high temperatures above 27 C would affect the metabolic rate and probably induce early hunger

(c) *Salinity* has recently come into prominence as a factor of considerable possible importance as a result of the findings in relation to the species of shark responsible for attack on humans Since the species (*Carcharinus zambezensis*) which is probably responsible for the majority of attacks in our area has a strong affinity for fresh water it is possible that the presence of flood water from rivers inshore areas frequented by bathers has an attractant effect on these sharks

Salinity determinations of water samples taken immediately after the two most recent attacks have therefore been carried out and were 35 13‰ (R N) and 34 79‰ (C H) showing that contamination by fresh water could have taken place in the first case and that it almost certainly did take place in the second case Salinities of surface oceanic water ten miles offshore average 35 4‰

(d) *Depths* of attack have ranged from two to [illegible] in the ten cases for which the depth was available. The shall[illegible] three feet (M.L.) took place alongside a channel ten feet in depth.
(e) *Distance from the shore* varied from thirty feet [illegible] and forty feet in the ten cases for which the data were available.
(f) *Geomorphology of the beaches and sea-floor* is considered to be an important factor in relation to shark attack along the Natal coast. In nine cases out of ten for which the information was available the attack took place either in or in the immediate vicinity of a relatively deep channel. The presence of a channel provides comfortable access for sharks of large size to the shallow bathing areas.
(g) *Condition of the sky* apparently bears no relation to shark attack since approximately half the attacks investigated took place in bright sun and half with an overcast sky.
(h) *Colour of costume* has no apparent effect and bears out the recent findings of Gilbert, Xth Pacific Science Congress (1961), that the retinas of the sharks he investigated did not possess cones and were therefore not able to perceive colour. Gilbert also established that certain sharks possess vision particularly well adapted to seeing in low light intensities.

It should be stressed that the colour of a victim's skin or clothing in relation to the background is important since strong contrast would facilitate the ability of the shark to locate its prey by means of vision.

The presence of a bright piece of jewellery might also have some significance.
(i) *Date and time of attack.* Of the eight attacks that took place off the east coast of South Africa, seven occurred in summer and one in autumn. Of the three cases that occurred farther to the north, one took place in summer and two in autumn. These data tend to confirm the general tendency for shark attacks to occur in summer between latitudes 20–40° S. Six out of ten attacks took place between 1400 and 1700 hours but the remaining four attacks took place between 0900 and 1100.
(j) *State of tide and the phase of the moon* appear to have no bearing on shark attack according to the records obtained for ten cases.
(k) *Offshore whaling* takes place from the Durban base during the autumn and winter months. The towing in of whale carcases from offshore brings in Blue Pointer sharks *Carcharodon carcharias* (Linnaeus), Tiger Sharks *Galeocerdo cuvier* (le Sueur), Makos *Isurus* spp. and Hammerheads *Sphyrna* spp. and accounts for these species being caught from the north pier by sport fishermen at this time of the year.

It is almost certain, however, that the majority of attacks on humans are made by inshore species and it seems unlikely that the oceanic sharks brought in by the whalers can be held responsible for the majority of attacks off the Natal south coast.
(l) *Discharge of sewage and industrial effluent* takes place at a number of points along the east coast of South Africa. There is as yet no positive evidence that large sharks are attracted to these outfall points.
(m) *Summary.* It is considered that the factors which are of the greatest importance in relation to shark attack off the east coast of South Africa are the combined effects of high temperature and contamination of inshore areas by fresh water from rivers, the presence of deep channels in the vicinity of relatively shallow bathing areas

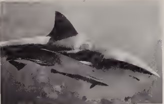


Fig. 4. The Zambezi River Shark (*C. zambezensis*) with remoras in Durban Aquarium.

Fig. [illegible] Shark victim P.S. [illegible] African male aged 22 years.

the presence of *Carcharinus zambezensis* in inshore areas and the increasing use of the sea as a recreational outlet by humans in this country

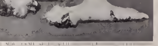
(D) *Species of Shark responsible for Attack on Humans in South Africa* In a detailed examination of eleven cases of shark attack with specific reference to the species of shark involved it has been possible to make one certain identification in the case of an African male P S by examination of tooth fragments (see Fig 3) extracted from the femur of the victim (Davies and D Aubrey 1961) and ten probable identifications from wound characteristics

In these eleven attacks it appears that only two species of shark were involved and that out of the eleven attacks the shark responsible for one was probably a Ragged toothed Shark *Carcharias taurus* Rafinesque (Campbell Davies and Copley 1960) while the remaining ten attacks were almost certainly made by the Zambezi River Shark *Carcharinus zambezensis* Peters, known locally as the Shovel nosed Grey or Slipway Grey (see Fig 4)

The evidence in favour of *C zambezensis* being the most dangerous species from the point of view of shark attack on humans in the Natal area is considerable

The certain identification of *C zambezensis* in the case of P S represented a major advance in the determination of the species involved in shark attack The characteristics of P S s wounds (see Fig 5) are striking in that they are clean cut amputations made by teeth with efficient cutting edges and jaws with immense power The skin edges and severed muscles are as clean cut as if they had been carried out with a knife The same characteristics are strikingly evident in the cases of M L (Davies and D Aubrey 1961) (see Fig. 6), G Z (D Aubrey and Davies, 1961) (see Fig 7), and R N (see Fig 8) In the case of M M (Davies 1961 c) three lesions on the femur characteristic of the shape of the teeth of *C zambezensis* were found

Although closely related species occur in shallow water in this area for example *C obscurus* (small specimens), *C limbatus* Muller and Henle and other Carcharinids none of these species has any particular affinity for fresh water and their characteristics on the basis of behaviour studies in the Durban Aquarium and accounts from divers able to distinguish them from *C zambezensis* are that for the sizes that occur in this area they are generally timid



[illegible]

Fig. 7. [illegible]

[illegible]

The behaviour of *C. zambezensis* based on the same information is quite different. It is always inclined to be offensive and will attack and kill large fish in the aquarium at times without eating them.

Zambezi River Sharks weighing 150–300 lbs. are frequently caught by surf fishermen along the Natal coast. It has been estimated from measurements of the sweep of the jaws measured on the wounds of three victims that the sizes of the sharks responsible were approximately 100 lbs., 200 lbs. and 200 lbs. A specimen of *C. zambezensis* weighing 160 lbs. made an attempt to attack a diver in the aquarium in 1960.

The Zambezi Shark is common in inshore waters in the area most seriously affected by shark attack. It has an affinity for fresh water (small specimens have been recorded from 280 miles from the shore in the Zambezi River system) (Jubb, 1961) and flood water from rivers along the Natal coast is frequently present during the summer months. It is a particularly ferocious species which will attack large fish without apparent provocation and not for food.

C. zambezensis is very close to (and may be found to be the same species as) *C. leucas*, the American Bullshark, which has recently been shown to be synonymous with *C. nicaraguensis* (Gill and Bransford) (Bigelow and Schroeder, 1961) the shark from Lake Nicaragua which occurs in fresh water. *C. nicaraguensis* is known to attack man in fresh water and is said to have attacked humans in inshore waters in the sea.

II. Clinical Pathology

(A) *The Nature of the Syndrome of Shark Attack.* It is considered that opinions on the prognosis and treatment of shark attack on humans should be based on actual observation of such cases. The principles that underlie the treatment of battle casualties or the reaction of laboratory animals to limb amputations do not necessarily apply to cases of shark attack since the wholly unexpected nature and extreme brevity of a shark attack can be expected to create mental agitation in excess of that of a battle casualty. In addition, the victim may be injured in deep water a considerable distance from the shore; he may have to swim through a strong surf in a deeply shocked condition, having sustained a heavy loss of blood and hampered by a useless limb. Having reached the shore the victim is faced with handling by untrained lay people and the prospect that first aid facilities for treating such cases are generally inadequate.

The latter situation is no longer true of the bathing beaches of the north and south coasts of Natal where, as a result of the recommendations of this Institute, there is a highly organized system of beach treatment of shark victims, which includes:

(1) plasma deposits on the beaches at thirty places on an eighty mile coast;

(2) the stationing of life-savers expert in the emergency measures for beach treatment and able to reconstitute plasma; and

(3) excellent organization of local doctors, which ensures that a doctor is on the scene within minutes of an attack.

Doctors on holiday along the Natal coast are informed where the nearest *beach*

pack of plasma is available, and as a result have been able to render emergency treatment

The syndrome of shark attack is one therefore that combines extreme neurogenic shock, torrential blood loss and acute physical exhaustion. This, taken with the fact that scanty facilities exist for treatment, necessitates a high degree of organization along any coast if doctors handling such cases can do anything to decrease the overall world mortality of 49 per cent which at present is the case in these injuries (Schultz, 1958).

(B) *Effects of the Bite*

(a) *Local*

(1) *Mechanical*

(i) *Cutting*. The cutting effect of shark bite is seen most clearly in the bites caused by the continuously aligned teeth of, for example, the Grey Sharks (*Carcharinidae*) (see Fig. 9) and the type of lesion caused by such jaws is shown in Fig. 5. The major effect in these is to cause massive blood loss because of deep incisions and the clean cut nature of the wound. The problem is therefore the replacement of blood volume and such cases require very large amounts of blood and plasma; the case of M.M., shown in Fig. 10, required twenty-one pints of blood and plasma during the three days after admission—that is, approximately twice the normal circulating blood volume of the patient. A proportion of this loss was due to serious effusion from the very large extent of exposed and damaged muscle. Infection is not nearly as great a problem here as in bites causing deeply punctured wounds such as those of the Ragged-toothed Sharks. Furthermore, the volume of exudate in this type of wound is so great that the local use of antibiotic powders as a means of combating infection is probably quite ineffective.

(ii) *Crushing*. Insufficient attention has been paid to the crushing component of a shark's bite, even in those sharks which cut cleanly. This is well illustrated in two of our cases. In Fig. 5, a fatal case (P.S.), X-rays (see Fig. 11) showed a degree of comminution of both femora that one would have expected of a severe motor accident and emphasized the enormous crushing power of a clean-cutting jaw in a shark of sufficient size. In this case, the force of the bite was enough

[illegible]

Fig 10 [illegible] M M [illegible]

to break off two fragments of the shark's teeth [illegible] the location of the shark corresponded to [illegible] estimated In the other case (see Fig 10) the importance of the crushing effects of the bite of a Grey Shark on soft tissues which had not been severed is accentuated Here the shark cut the femoral artery in the middle of its course without damaging the profunda but at the same time removed and cut most of the muscles of the thigh with the exception of the hamstrings and a small part of the quadriceps An adequate reconstruction of the femoral artery was performed within two hours of the attack but it failed because of the fact that all the venous return to the limb had been destroyed not only by direct cutting but because it had been crushed out of existence in those muscles which had not been severed This shows how early and effective arterial reconstruction can be baulked of success by destruction of venous return

(iii) *Tearing Effects* A careful study by Campbell Davies and Copley (1960) and Davies (1960 b) was made of the wounds of M H aged 17 which are thought to have been caused by a Ragged toothed Shark (*Carcharias taurus*) This species has widely spaced, prong-like teeth (see Fig 12) and is unable to make a clean-cut bite The function of the teeth is one of seizing rather than cutting When this shark bites a human the effect is for the teeth to tear away a big piece of tissue (see Fig 13) The extensive wound in the flank of the boy was the result of the tearing away of his entire lateral abdominal wall In this case,

[illegible]

[illegible] the small bowel was outside the abdominal cavity and was extensively perforated, the right kidney was exposed, and the twelfth rib and crested lesions were made in the crest of the ilium (see Fig. 11). It is likely that had the wound been caused by the clean cutting jaws of the Grey Shark type the patient would have expired at once. In this case, therefore, emphasis was not on blood loss although shock was considerable. The shark made two tentative bites, one on the right arm and one on the right leg, before making a more determined attack on the abdomen. The limb wounds provided evidence concerning the nature of the shark responsible, as the lesions caused by the teeth were very widely spaced, extremely deep and a throat swab could be passed with ease into them. The knee joint was opened by a lesion less than 2 mm square. In this type of lesion deep-seated infection is possible and it is fortunate that the newer antibiotics have shown their effectiveness in combatting the bacterial flora of the shark's teeth. For this reason no emergency measures are necessary unless vital structures such as the capsule of the knee joint are affected. In this case the lateral popliteal nerve was damaged. The abdominal wound with multiple perforation of bowel resulted in gross peritonitis which cleared satisfactorily after parenteral administration of oxytetracycline—there being only a single spike of temperature after the operation.

[illegible]

[illegible]

Fig. 14. Sfatk sie[illegible] M.H. [illegible]

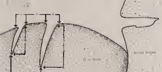


Fig. 15. Drawing from X ray [illegible] M.H. [illegible]

(II) *Bacteriological*

In the past shark bite[illegible]ed is becoming [illegible] severely infected It was customary to exc[illegible] th[illegible] ds widely in order [illegible] prevent this Investi gations carried out at th[illegible] [illegible]phic Research Inst[illegible] [illegible] Durban during 1959 and 1960 showed th[illegible] [illegible] pathogenic org[illegible] m[illegible]y be present on the teeth of living sharks It [illegible] *Par[illegible]olon* bacillus which [illegible] strongly haemo lytic It is however sensitive to antibiotics such as chlortetracycline chloram- phenicol and oxytetracycline though it is resistant to penicillin its fermentation properties are described elsewhere (Campbell 1961)

The same organism was found in the wounds of M H (see Fig 13) which were thought to have been caused by a Ragged toothed Shark (*C taurus*) and fermentation features were the same as those isolated the year before by the Institute workers Campbell Davies and Drummond (1960) As mentioned above this was probably the first recorded instance of recovery from major abdominal injury caused by shark bite These injuries consisted of the severing of the ileum from the caecum with extensive puncturing of the caecum and parts of the small bowel Intravenous oxytetracycline kept this gross peritoneal soiling at bay Chloramphenicol was used very successfully in two of the Port Shepstone cases in one of whom Feinberg (pers comm 1960) there were very extensive superficial lacerations the loss of the entire arm and one breast in a young girl This was the first case in which beach treatment with intravenous fluids was used with conspicuous success Although tetanus or gangrene has not so far been encountered as has been reported from Australia (Cleland 1960) it is believed that it would be wise to use the antisera in treatment of shark bites especially in view of the fact that the Natal surf is often contaminated by muddy water from nearby rivers during the summer months It is evident therefore that one of the more serious factors complicating wounds caused by shark attack in the past—infection—has not nearly the same significance as it had before

(III) *Radiological* There are two reasons for X raying the wounds of shark victims

(a) With reference to treatment it is important for the surgeon to know if any foreign bodies are present in the wound

(b) With reference to investigations on the species of shark responsible the recovery of teeth fragments and the study of defects in the bones contribute valuable evidence in relation to the identification of attacking species

In spite of their having arisen from cartilaginous tissue the teeth of sharks are radio opaque In the case of P S (see Fig 3) post mortem X rays of the lower end of the femur were responsible for the first recorded instance in South Africa of the recovery of tooth fragments large enough for the accurate identification of the species of shark responsible and an estimation of its size to be made In this case a Zambezi River Shark *Carcharinus zambezensis* of approximate weight 1 000 lbs was found to be the attacker by comparing the fragments with jaws in the extensive collection at the Institute in Durban

A pictorial reconstruction of tomographs and X-rays of the iliac crest of the case M H (see Fig 15) show bony lesions which probably exclude sharks with

[illegible] dentition type and [illegible] and probably [illegible] the Ragged-toothed Shark [illegible] Grey Shark it is likely that the entire [illegible]

As accurate X-ray definition [illegible] injury to bones caused by shark attack it is suggested th[illegible] all such lesions should be smeared with sterile B.I.P.P. (bismuth [illegible] paraffin paste) so that the lesions will show up clearly in later X-[illegible]

(b) *General*

(i) *Prognosis according to the major vessels severed: the Durban classification*

On the basis of examination of eight recent cases from the Natal region it is likely that all except one were caused by Grey Sharks (*Carcharinidae*) possibly a single species *C. zambezensis*. As stated above, the wounds are clean-cut and the emphasis is upon severe blood loss. There appears to be a direct relationship between prognosis and the major vessels severed. This has also been observed in previous cases examined by doctors on the Natal south coast (Feinberg 1960) and from the case notes of the Addington Hospital, Durban (six cases 1943–44). The following table illustrates this prognostic classification.

*Grade of injury	Major vessels severed or description of wounds	Prognosis
Grade One	Both femoral arteries One femoral and one posterior tibial One femoral artery in upper third	Fatal
Grade Two	One femoral artery in lower two-thirds One brachial artery Two posterior tibials Abdominal wounds with bowel involvement (major)	Should survive if proper beach treatment is available
Grade Three	One posterior tibial Superficial limb wounds: no vessels cut Superficial abdominal wounds: no peritoneal involvement Both forearm vessels (probably)—no case seen	Always live if properly treated on the beach (but see Fig. 7)

(i) *Grade One*. A good example of a Grade One injury which was almost instantaneously fatal is seen in P.S. (see Fig. 5). It is of interest to note that like

many of the Australian attacks, it was preceded by a "bump" on the chest which lifted the victim vertically out of the water before the shark made its first bite. When the victim fell back he was viciously attacked and lost both legs in two bites. One leg was severed at the level of the greater trochanter and the other at the level of the knee joint, both bites causing extensive bony damage (see Fig. 5). It was evident from the nature and result of this attack that it was caused by a large shark and the examination of tooth fragments (see Fig. 3) showed that its weight was approximately 1,000 lbs. Also included in the Grade One category are cases in which a single femoral artery has been severed in the femoral triangle, i.e. in its upper third, as it is almost impossible to put an effective tourniquet so high on the leg; only immediate heavy digital or thumb pressure could have any effect on such a torrential blood loss. This occurred in the case of R.N., a 13 year-old boy (see Fig. 8), who was attacked by a shark of the Grey type (note the very clean cut edges to the wound). The femoral artery of this victim was severed at the junction of the upper and middle thirds of its course and the patient died within three minutes while he was being brought out of the surf. It seems probable that early treatment and excellent facilities are of little help in Grade One injuries.

(ii) *Grade Two.* A straightforward Grade Two injury is seen in M.M. (see Fig. 10) with cutting of the femoral vessel just above the hole in the *adductor magnus* and without cutting of the profunda. This victim was discussed previously in connection with severe blood loss and the crushing effects of shark bite: he owes his life to effective beach resuscitation. Fig. 13 shows the case of abdominal wounds involving the removal of the right abdominal wall and in widespread bowel perforation which, it is considered, should bring the case into the category of Grade Two. Tomograms of the iliac crest are shown diagrammatically in Fig. 15. This case has been reported in detail in a previous paper (Campbell, Davies and Copley, 1960).

(iii) *Grade Three.* Fig. 6 shows a straightforward Grade Three injury apparently caused by a small shark of the Grey type: both tibial vessels were severed and the foot was disarticulated at the ankle joint, the edges of the muscles being very clean-cut. The foot was held on by a piece of skin but was amputated by the doctor on the beach. The patient made a good recovery after efficient beach therapy. Fig. 7 shows another example of a Grade Three injury, with severance of the posterior tibial vessel in one leg. The attack took place at East London (see Fig. 1). The victim in this case was denied beach resuscitation and was rushed to hospital but he died soon after the ambulance left. A Durban life saver has survived two Grade Three attacks three years apart: that patients so lightly injured should ever die, is a reflection on the lack of suitable emergency services existing at that time.

With reference to the gradings of shark attack injuries, it appears that Grade One cases are hopeless, while with proper treatment all Grade Three cases should survive. The Grade Two case presents a real challenge to the persons and organizations concerned with emergency services on bathing beaches.

(C) *The Differential Diagnosis of Injuries caused by Sharks and other Predaceous Marine Fishes*

Attacks on man are not confined to sharks and among the other fishes known to attack humans are the barracudas (*Sphyraena* spp.) (Halstead, 1959).

Barracuda are found off the east coast of South Africa and have at times been held responsible for attacks on humans. There is, however, no authenticated instance of a barracuda attack in this area and, in addition, the majority of barracuda which occur off the Natal north and south coasts are of small size.

The possible incrimination of the barracuda in South African waters is complicated by the fact that a common gamefish *Scomberomorus commersoni* Lacepede, one of the Spanish mackerels, is incorrectly called the "barracuda", while the true barracuda (*Sphyraena*) is known as the "sea-pike". There is no known record of an unprovoked attack on a human by a Spanish mackerel (*Scomberomorus*).

During 1961 a provoked attack on a bather was made by a Spanish mackerel (*Scomberomorus commersoni*) while it was being landed by an angler. Photographs of the wound were taken and have been kept as a permanent record of this type of bite. On the basis of the examination of this case, there would be little difficulty in differentiating these wounds from those caused by a shark.

Another incentive to hold fishes other than sharks responsible for attack on humans is related to the economics of the tourist industry. Shark attack has a most adverse effect on tourism. An attack by a barracuda is far less serious in its implications than a shark attack and many shark attacks are therefore claimed by local authorities to have been made by barracuda as a means of countering the adverse effects of shark attack.

[illegible] drowning J.V. showing damage caused by sharks after death [illegible]

(D) *Med[illegible] Shark [illegible]*

The body [illegible] was washed [illegible] Margate (see Fig 16) was [illegible] on the following day [illegible] lethal abdominal or thoracic wounds could be destroyed if a body were [illegible] dumped in the sea at the time of year when Grey Sharks are numerous in the area It also became evident from this investigation that the sharks responsible probably belonged to the family *Carcharinidae* (those with cutting teeth) rather than the *Carchariidae* (those with tearing teeth)

In the "Shark-arm Case" which was reported from Australia (Coppleson 1959) the fact that a large shark disgorged a human arm shortly after being put into an aquarium resulted in the prosecution of a man for murder It is interesting to record that human tissue may remain undigested in the stomach of a shark for considerable periods in this case a minimum of eight days and a possible maximum of sixteen days

III Treatment

(A) *Introduction*

The Shark Attack File kept by Dr Leonard P Schultz for the A I B S Shark Research Panel contains records of 798 unprovoked attacks and shows that 390 individuals recovered and 408 died i e a mortality rate of 51 per cent It would be interesting to know what proportion of this high death rate could be ascribed to inadequate first aid services

In the spate of attacks on the Natal south coast in the last five years the doctors concerned with treatment achieved spectacular success with the beach treatment procedure they did not rush the patient to hospital and used special facilities that were available locally only when the patient had recovered from his initial extreme shock was he moved Judging by previous reports past treatment of shark attack included the tying of tourniquets and the immediate removal of the patient to hospital In the hospital radical surgery was usually performed mainly to offset the possibility of serious infection The words "the victim was rushed to hospital but died soon after admission" occur so frequently in Dr Coppleson's accounts that the possibility that the "rushing" contributed materially to the fatal outcome in these cases cannot be ignored

By the time the shark victim has reached the beach he is generally exhausted and shocked by the extreme exertion of struggling with the shark and the extra efforts that a crippled person has to make to swim through the surf to the beach Such a patient appears to fare far better spending 30 60 minutes lying quietly whether sedated or not in the head down position on the beach and kept cool—rather than being carried bodily to a waiting car in which he is propped up smothered in coats or blankets in a warm atmosphere suffering what is often a rough ride to the main road after which he faces the prospect of a hectic journey to hospital It is not surprising that such patients arrive at hospital dead or in a state of irreversible shock It is considered preferable to rush plasma or blood to the patient who should be left lying on the beach near where he was attacked If tourniquets are properly applied little additional harm can come to him if he is kept still cool and in the head down position Surf bathers are usually in good physical condition and if allowed a short time to

[illegible] mechanism [illegible] can be expected to make dramatic recoveries from shark attack. This point is borne out by the description of the case of M.H. (see Fig. 13) where there was recovery from a major abdominal wound with visceral involvement. There is little doubt that the doctor's immediate and well-advised treatment on the beach paved the way to this boy's miraculous recovery—and made it possible for subsequent major surgery to be performed which completed the requirements for his return to a normal life.

The main factors involved in this change of approach in the treatment of shark victims are, firstly, that it is now possible to provide powerful anti-shock measures for victims on the beach without moving them, and secondly, that the newer antibiotics are remarkably effective in combatting infection in wounds.

(B) *Adjuvant Therapeutic Measures on the Beach* (The use of the Feinberg Pack)

Because of the proximity of his rooms to a beach where several shark attacks have occurred, a system of beach treatment of victims has been evolved by Dr. S. Feinberg of Margate, situated ten miles south of Port Shepstone (see Fig. 2). He has designed a special emergency pack, which contains the following:

one vacolitre of normal saline
one bottle dried human plasma
one bottle plasma diluent
two plastic intravenous giving sets
ampoules of morphine, coramine and noradrenaline
syringe
swabs
spirit
tourniquets

A doctor can keep the Feinberg Pack in the back of his car or in his rooms if he is in a shark attack area. This type of pack with slight modifications (e.g. containing two bottles of plasma) has now been placed at thirty places along one hundred miles of the Natal coast. The use of the pack is described below. The use of plasma is preferred to Dextran, as the latter may deteriorate more rapidly in hot climates. All plasma supplies are replaced every six months.

(C) *Preparations that should be made in Shark Areas*

The following preparatory measures are recommended for doctors involved in the emergency treatment of shark victims:

(a) Ensure that a Feinberg Pack is available near all bathing beaches where attacks have occurred or where there is known to be a large shark population.

(b) Doctors near beaches of this type should have some sort of rota, so that the telephone exchange knows where they can be found.

(c) Doctors should ensure that local hospitals have reserve supplies of human plasma. Most hospitals in Natal have not only plasma reserves but supplies of Group O blood as well.

(d) The public should be urged to bathe only from protected beaches and should rigidly observe the instructions of the life savers.

(D) *Rescue and Treatment in Shark Attack*

(a) *In the Water* Try to chase the shark away as it may make a second attack Help the patient ashore as quickly as possible

(b) *On the Beach* Move the patient no farther up the beach than is required to avoid wave action and place him at once in the head-down position on the slope of the beach Apply tourniquets at once Lay people should refrain from doing anything more than this and should call a doctor at once

Give no warm drinks or alcohol cover the patient with a light wrap or towel Sips of fresh water may be given Attempt no other local measures apart from stopping bleeding and covering the wounds with a clean towel

The doctor should use a Feinberg Pack at once The bottle of saline should be set up as soon as possible While this is running the plasma should be reconstituted and immediately substituted Send for more plasma or blood if possible

Give morphine gr ¼, whether pain is present or not (see below) Record pulse and blood pressure frequently *Severe shock should be a contra indication to moving the victim* Lay people should not move the patient without medical supervision When significant improvement is visible and the patient is considered ready to be moved forewarn the hospital Do not move to any centre not fully competent to carry on with further intravenous therapy

Record pulse and blood pressure as the patient leaves the beach together with a note of the drugs given and give this to the ambulance driver who should drive slowly Note also, for the benefit of the surgeon if the wound is very jagged, whether it appears to have involved the abdominal cavity or not and if the sea was contaminated by any effluent or other discoloured material Do not remove the needle from the vein even if the drip is finished as the surgeon may be very grateful for its presence there later

(c) *At the Casualty Department* Since the hospital has been forewarned group O blood should be ready for instant administration—or if it is not possible to arrange this at once further plasma infusions should be prepared Blood samples should be taken at once for routine and emergency compatability and for hæmoglobin estimation

Blood pressures should be checked against the beach readings

It has been advisable to give anti tetanus serum and gas gangrene anti toxin serum at once and an injection of a large dose of one of the newer antibiotics intramuscularly

We advise that the dressings should not be tampered with in the casualty department

If the patient is still shocked delay transfer to the surgical ward

(d) *In the Surgical Wards and the Theatre*

Clinical Features

Note whether resuscitation is complete and extent of wound contamination Record carefully the following features

1 The diameter of the sweep of the jaws from the wounds
2 The presence of bony lesions
3 The characteristics of the skin punctures

4. The characteristics [illegible] the skin edges (cle[illegible] [illegible] jagged)
5. Whether there are two discrete rows of teeth marks visible [illegible] bites
6. The distance between the lesions made by teeth in the front row
7. Any skin lesions that may have been made by bumps by the shark

Careful photographic records should be made in colour and black and white if possible of all wounds (There is a 24-hour standby of photographic service for such attacks at the Oceanographic Research Institute in Durban)

(c) *Treatment*

Delay operating as long as possible Be conservative in all surgical measures Remove dressings after induction and swab all lesions with sterile throat swabs which should be inserted deeply into any lesions These should be plated out *at once* for organism sensitivity Having made careful measurements of all wounds as suggested above smear any visible bony defects with sterile B I P paste to facilitate subsequent X ray examination Debride only obvious necrotic tissue and do not attempt to remove all tissue involved If blood supply is intact even the most infected and lacerated limb can be saved with return of function

Do not attempt tendon suture unless the wound is very clean

If the bowel is involved resect widely and exteriorize

Do early skin grafting wherever possible to preserve nerves tendons vessels joints and even muscles and to reduce the post-operative illness of trauma

(f) *Post-operative Care* These measures will be governed by the usual surgical principles In such healthy patients the surgeon can expect a very clean field in a short time with the combination of healthy tissues and powerful antibiotics the antibiotic should be chosen or changed according to the sensitivity of the bacteria from the wound Intravenous therapy should not be prolonged and intensive physiotherapy instituted as soon as possible

(E) *Preventive Measures in Shark Attack*

World mortality of shark attack is approximately 49 per cent

In Natal even with the most modern methods of treatment we can still expect a high mortality The chief remedy is in prevention and this is of course outside the scope of the doctor It would appear impossible to prevent people bathing upon unprotected beaches since there are few resorts that can afford such costly barriers In addition to avoiding such beaches bathers should avoid bathing in muddy water of whatever depth they should remove ornaments that reflect the light, but above all should heed the directions of the life savers As long as bathers neglect these few simple rules doctors and scientists can expect to have ample opportunity of studying further cases of shark attack It seems strongly evident that the greatest factor involved in the saving of shark victims is timely emergency treatment probably the greatest task of the life-saver or ambulance worker on the spot will be to protect the victim from members of the public who can seldom restrain their desire to do something for seriously injured people

Summary of Part III

Three points appear to underlie the modern treatment of shark attack

(1) Leave the patient lying flat in the head down position on the beach just out

[illegible] people should [illegible] [illegible] purpose. This is probably [illegible] [illegible]

(2) Carry out thorough beach resuscitation. Rush the plasma to the patient and not the patient to the plasma. Areas such as the Natal south coast, where attacks are concentrated, are well advised to adopt the measures mentioned above under the heading "Preparations that should be made in shark areas".

(3) Rely upon the power of the newer antibiotics which have reduced the need for radical emergency surgery.

ADDENDUM I

On 10th December 1961, under the respective Chairmanship and the Secretaryship of the two authors of this paper, an informal Symposium on the Emergency Treatment of the Victims of Shark Attack was held at the Oceanographic Research Institute in Durban. Sixteen coastal doctors attended, most of whom had had personal experience of shark attack and many of whom had had experience of battle injuries. There was one overseas observer. Publication of the Proceedings of this Symposium are in preparation.

The following resolutions were minuted:

(1) That the meeting condemned unanimously the "rushing" of shark victims to hospital.

(2) That as remarkable recovery has been recorded in severe cases (even without intravenous therapy) by keeping the patient still in the head-down position on the beach, that this measure with effective tourniquets should be the basis of the treatment of all shark victims.

(3) The experience of doctors present suggested that the patient should be kept for at least thirty minutes on the beach before being moved, whether intravenous therapy is available or not.

(4) It was unanimously agreed that all patients whether in pain or not should have the benefit of sedation and it was recommended that gr. $\frac{1}{4}$ of morphine was the drug and dosage of choice.

(5) That where intravenous facilities were made available, a vacolitre of normal saline should be run in at once, while the doctor reconstitutes the plasma. Natal life savers have been trained to reconstitute plasma, which is then usually ready when the doctor arrives.

(6) That no victim should be moved unless under the supervision of a doctor; the patient is better left still rather than moved precipitately under lay advice.

(7) That no patient should be moved unless he has recovered from shock completely; it has been found in these patients that the ambulance ride, even in patients who have recovered satisfactorily on the beach, is a very shock-making procedure.

(8) That Feinberg Packs with saline and two bottles of plasma should be made available at all populous bathing beaches where water temperatures ever exceed 65° F.

(9) That as doctors on holiday are so often primarily involved in the treatment of such cases, that attempts should be made to inform visitors at each resort where a Feinberg Pack is available.

... recommendation ... subject to the availability of ... by ... thoroughly trained in this ... of ... therapy.

... recommendations ... the Oceanographic Research Institute ... north and south Natal coasts and on the ... near East London and Port Elizabeth have had modified Feinberg Packs made available and local ... have been extensively trained in the basic treatment of shark attacks and in the ... (infusion of plasma).

Acknowledgments

We wish to acknowledge our indebtedness to (a) the Medical Superintendents of the Addington Hospital, Durban and the Port Shepstone Hospital for making available records of past victims of shark attack; (b) the many doctors of the south coast who have done so much to help our investigations, in particular Drs. S. Feinberg, I. Dalzell and P. Moore; (c) the Consultant Surgeons at the Addington Hospital, in particular Messrs. N. Butcher, M. Stein, R. Mundy and the late A. C. Copley who have allowed us to be present in their theatres for purposes of examinations of the wounds and photography; (d) Dr. N. Sacks of the Addington Hospital for his help with X-rays and for permission to reproduce the X-ray photographs; (e) Dr. G. Drummond for his co-operation on the bacteriological studies of sharks' mouths; (f) Miss J. D'Aubrey and Miss R. Ahrens of the Oceanographic Research Institute, for their assistance with the photography and drawing of the diagrams; (g) the Editors of the *S.A. Medical Journal* and *Medical Proceedings* for allowing the reproduction of certain material and figures previously published.

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PART VI. A CONCISE TREATISE ON MARINE SCIENCE

Chapter IV – Deep Sea Exploration

By Surgeon Commander J GLASS R N

(An amended version of "Notes on the Physics Physiology and Fascination of Deep Diving" Glass J *Med Jour of Malaya* 12 4 622-636 1958)

Part One—Deep Diving

The story of modern deep diving opens with the invention by Augustus Siebe in 1819 of the open dress diving rig Manually pumped air was supplied into the diver s helmet through a hose while used air was discharged through an outlet valve It was soon realized that the diver was subjected to varying pressures additional to the 15 lbs per square inch atmospheric pressure on the surface To overcome this Siebe in 1820 designed the closed dress which could accommodate the diver under air pressure in equilibrium with the sea pressure surrounding him This rig plus the additions of safety valves and telephones remained the standard dress for over 100 years (Craig 1938)

The term " deep diving " is taken to mean a diving operation at a depth which exceeds 30 fathoms

The diver s problem then is the weight of the water above him much the same as we have on the surface a weight of air over us equal to approximately 15 lbs per square inch The atmospheric pressure our normal pressure equilibrium in which we carry out our physiological functions alters the higher we go in altitude as the atmospheric pressure decreases This necessitates an increased respiration rate to sustain our O_2 requirement In figures at a height of 14 000 feet above sea level the pressure drops 0 4 of an atmosphere i e from 14 7 lbs/sq inch to about 8 7 lbs/sq inch a drop of 6 lbs which is a 40 per cent decrease and this can cause acute respiratory distress evidenced by marked panting by those unaccustomed to these heights

In the case of diving sea water being the heavier for every foot of descent below surface there is then a weight of 64 lbs pressing each square foot of a diver s body surface or 0 445 lbs every square inch of this surface area In relation to the above example of 6 lbs pressure decrease for an ascent of 14 000 feet in air we see in the descent into the sea at a depth of 14 feet the raising of the pressure by an additional 6 lbs and at 33 feet descent the pressure is an additional 14 7 lbs per square inch There is then an atmospheric pressure increase for every 33 feet descent into the sea. Of the tremendous forces at play consider the pressure at 132 feet down which is 3¾ tons per square foot or 59 lbs per square inch In relation to the diver s whole body the pressure would be about 53 tons (Ellesberg 1940)

The Physics of Diving

When the pressure of the atmosphere is included in calculations of pressure at sea depths it is sometimes referred to as *absolute pressure*. This measurement is not used in general discussion. The pressure recorded on gauges in deep diving is given as that pressure not including the atmospheric pressure and is known as the "excess pressure" or "gauge pressure" or more commonly just "pressure".

Volume, the quantity of a gas in a confined space at atmospheric pressure, according to Boyle's Law varies inversely as the absolute pressure, the temperature being constant. If a pressure of 90 lbs/sq. inch of air above atmospheric pressure is required, then dividing 90 by 15 we calculate that 6 volumes of air is the additional requirement. The next theorem is that the density of a gas varies directly as the absolute pressure. When the question of temperature enters, the theorem is that there is a proportional rise and fall of the temperature of air in a confined space as the absolute pressure rises or falls. When the pressure is constant, then Charles' Law applies which states that gases expand or contract 1/273rd of their volume for each degree rise or fall from 0° centigrade.

Charles' and Boyle's Laws may be combined and formulated

$$\frac{V_1P_1}{273+t_1}=\frac{V_2P_2}{273+t_2}$$

V_1 = given volume
V_2 = required volume
t_1 = given temperature
t_2 = required temperature
P_1 = given pressure absolute
P_2 = required pressure absolute

The diver requires the same volume of air at whatever depth he may be. If the supply is being taken in at 1.5 cubic feet a minute at the surface, then 3 cubic feet is required at 33 feet depth, 4.5 cubic feet at 66 feet and 6 cubic feet at 99 feet. A calculation to find the required amount of air to be supplied at the given depth is made by the following formula

$$\left(\frac{\text{Depth in feet}+33}{33}\right)\times 1.5 = \text{volume of air at atmospheric pressure per minute}$$

e.g. at 66 ft. sea depth, thus $\left(\frac{66+33}{33}\right)\times 1.5=\frac{99}{33}\times 1.5=4.5$ cu. ft. per minute

At a depth of 33 fathoms, hand worked pumps are not considered suitable to provide air for deep divers. The quantity of air at that depth required per minute would be 10.5 cu. feet. In practice hand pumps are usually confined to depths of 20 fathoms or less.

The Hazards of Diving

Caisson Disease

One of the first investigators to attempt to unravel the mystery of caisson disease or the "bends" was Professor Le Roy de Mericourt in 1860. His theory of the diver's blood becoming charged with air which he breathed under pressure as the cause of the disease was close to the truth. It was, however, his countryman Paul Bert in 1878 who explained the ætiology fully and advised the engineers on the

[illegible] engineers (L.R.sh[illegible] 1[illegible])

The physiological problem as we know it [illegible] lable by having knowledge of the two fixed variables depth and time. The diver at a depth of four atmospheres of pressure has that pressure transmitted to the thoracic cavity and the nitrogen in the air, instead of being exhaled through the exhaust valves, passes through the alveoli and dissolves into the blood of the alveolar capillaries. With continued respiration more and more nitrogen enters the blood stream and as the blood circulates the nitrogen under pressure continues to enter the tissues of the diver's body. The rate of absorption of nitrogen into the tissues is proportional to the depth (which governs the first variable of pressure) and the period he remains at that depth. Greater depth is directly related to a more rapid absorption of nitrogen and the increase in time at that depth is proportional to the increased quantity of gas dissolved into the blood stream. While the diver remains below he is unaware of this process taking place and it is only when he starts to surface that the manifestation becomes apparent as the reverse mechanism operates. As the pressure decreases on ascent the nitrogen comes out of solution in the blood stream and tissues and appears as bubbles. The more rapid the ascent the more nitrogen comes out and the bubbles expand. This might even froth the blood stream and cause in the more aggravated early cases immediate death or in less severe cases a crippling paralysis as the gas emboli become lodged in the spinal column.

The symptoms of minor degrees of the disease are noted as pain, particularly in the joints, knees, elbows and digits, which somehow favour the accumulation of minute gaseous emboli. For the early workers, aware of the cause, the remedy was a logical deduction which led to the practice of divers rising to the surface very slowly and steadily. The physiological process then would be the slow dissolution of nitrogen out of the tissues in small quantities not sufficient to give rise to bubbles and by normal respirations the diver would exhale the gas out of his helmet. This process was termed *decompression* and when this theory was first put into practice the results were not entirely satisfactory as there were many cases of caisson workers who developed a delayed onset of this disease. In 1906 the Admiralty requested Professor J. S. Haldane and Lieutenant Damant, R.N., to study the problem. The result of their observations showed that it was an error to rise slowly and steadily as this gradual decompression did not mean absolute desaturation of the blood and tissues by nitrogen. The two scientists advised decompression in stages. It was then thought that the diver should rise from say *four* atmospheres directly to *two* atmospheres quickly. The rationale behind this action was the theory that when the diver rose to half his pressure in one stage there would be a rapid desaturation of a large quantity of nitrogen into the blood stream but under pressure enough (at two atmospheres) to prevent the formation of bubbles of any size liable to cause symptoms. After a time at the first stage the diver was to rise to the second stage, a depth half the pressure of stage one. In this given example he would be at a depth of one atmosphere. Again after a period the diver would rise to half the atmospheric pressure depth of stage three and so to the surface.

Haldane's theories and his decompression tables of depths and time intervals

recommended stages of decompression were very useful and results obtained following the schedule were excellent. The snag however was the omission of the variable nature of the human factor. The calculations were made to suit the normal man and it was soon observed that divers varied significantly from each other and from the "normal" and whereas the calculations from the tables would apply adequately for one diver, it might not be suitable for the next diver undergoing the same physical stress of depth, time at that depth, and weather conditions. Emotional stability, too, varies from diver to diver and the psychological aspect of the job in hand had to be considered.

Ellesberg (1940) noted an example of variance of physique which permitted Alexander Lambert, an American diver, to disregard the Haldane tables. This was not met with frequently. The Herculean diver made two or three dives a day to a depth of 27 fathoms and his diving periods lasted 70–75 minutes on the bottom while his ascent was only four or five minutes. According to the tables he should have taken 60 minutes for the rise and should not have attempted another dive that same day. Lambert did not suffer from the "bends" and a possible explanation in his case was that his blood, volume for volume, as compared to normal blood might have been considered of a denser nature and his very large thoracic cavity permitted a more rapid elimination of N_2 during breathing movements.

If in addition 2 per cent of an atmosphere of CO_2 is breathed there is a physiological dilatation of the cerebral vessels which helps the more rapid absorption of nitrogen by the brain thus giving rise to symptoms varying from exhilaration and a feeling of well being, to muscular inco-ordination and even loss of consciousness. This phenomena, nitrogen narcosis or rapture of the deeps, can affect divers at pressures in excess of 4 absolute atmospheres or a depth of 100 feet.

Where the air breathed is free of CO_2 these symptoms rarely appear in depths less than 150 feet. The symptoms reach a maximum intensity rapidly, within a few minutes. On decompression the symptoms rapidly disappear leaving no after effects. This explains why some divers evidence an apparent loss of memory and are unable to account for some of their activities at great depths. Those divers who are susceptible to nitrogen intoxication at the higher pressure should not be permitted to submerge again to that depth as they are a source of danger to themselves and their associates.

An interesting physiological coincidence is seen in the fact that atmosphere gases are very soluble in fat, and fat persons are thought to be more susceptible to caisson disease. Thus it is deemed inadvisable for those persons to be employed as divers or caisson workers. For this reason most veteran divers tend to be of lean build. Further investigation on this point of susceptibility might prove interesting.

One other common hazard is the result of exposure to excessive pressure because of some faulty balance within the diving rig and sea pressure, which can cause "squeeze" effects. To avoid this catastrophe the diving rig must be supplied with air at a pressure slightly greater than that of the surrounding sea pressure. Another precaution should be borne in mind whereby the pressure within the suit should be sufficient to cause a little air space in the suit just below the breast plate with the helmet completely full of air. The remainder of the suit should then be pressed

tightly against the diver by the sea pressure. This is the normal state of balance for working.

When the diver descends by a diving stage in U.S. practice or down a rope in British practice, on submersion he adjusts the air and exhaust valve for negative buoyancy. As he descends the pressure increases, breathing becomes more difficult, the eardrums bulge and become painful—at this stage it is wise to swallow hard which relieves the pressure in the cranial cavities as equilibrium is restored. Should the pressure in the rig be decreased so that the internal body pressure is lower than that of the sea about him, the sea will press in on his whole surface. The first sign of this is the "incipient squeeze", which is pressure on his legs forcing the blood out, causing pain. Fatalities occur when a diver falls suddenly to a greater depth from a rock shelf or by slipping down a sloping deck of a submerged wreck, before he can adjust the valves admitting more air into his rig. The result could be forcible ramming of the diver's body into the rigid helmet, causing instantaneous death.

The opposite action to squeezing is blowing up, which is equally dangerous and leaves the diver absolutely incapable in his now expanded rigid suit from averting disaster to himself. This phenomena is caused by some error in regulation of air flow into the suit, where the upset balance of pressure blows out the suit and pressure within the rig is greater than the sea pressure. As his suit swells he rises, the heavy foot ballast and metal helmet being ineffective in keeping him below. Now a vicious cycle starts, for as he rises the sea pressure decreases and the internal pressure in proportion rises so that the rig still further expands and the diver, now buoyant, will rapidly rise with his suit so extended that he is encased in a rigid suit where he is unable to bend his arms in order to get his fingers to the helmet air valve to shut it off. His one hope is to bump his chin on the internal valve in his helmet to open it—or better, to shout up his telephone to the tender to shut off the air. Failing that he will shoot to the surface and may ram the diving ship. Should he miss the diving ship he might arrive at such speed on the surface that if the air pressure is not turned off at once the suit could burst and cause the unfortunate diver much trouble if he fails to release the heavy items encasing him. Should he survive this length of time and his suit not burst, he may be subjected to a violent attack of bends if he remained below long enough to absorb a lot of nitrogen since there was no stage decompression practised, or to air embolism from the over distension of his lungs if he did not exhale adequately, and only prompt recompression can save him with very slow decompression in the chamber, once he has been recovered.

A less serious but exceedingly painful hazard is the result of air pressure in the catarrh blocked head cavities of divers complaining of catarrhal disorders. This may be evidenced by pressure on the middle ear cavity through the blocked eustachian tubes and of pressure in the maxillary and frontal sinuses via ducts leading to the nasal cavity which remain blocked. A pure physical phenomena takes place. The air pressure in the middle ear and nasal sinuses remains at normal atmospheric pressure during the dive if the ducts are blocked, and the pressure outside them increases, thus giving rise to intense pain. The best thing to do in these circumstances is for the diver to surface and remain on top until his cold or catarrh is cleared.

Mention has previously been made of the use of a telephone set in the helmet

in direct [illegible] personnel [illegible] No alteration in the [illegible] At a depth [illegible] the sound [illegible] communication by [illegible] unintelligible except [illegible] and practiced tender. The [illegible] for this is that when air [illegible] under pressure it gets heavier. It became apparent that air multiplies in weight per volume in direct proportion to the increased pressure it is subjected. We noted that at four atmospheric pressures air is four times as heavy than at one atmospheric pressure and at the increased pressures the normal speech mechanism finds difficulty in forming sounds over the phone. The sound becomes jumbled up. At that depth a diver cannot whisper or whistle so dense is the medium. Thus conversation at great depths is limited to some easily understood code between diver and tender to avoid lengthy discourse about the nature of the work on the part of the diver.

The Physiological Consideration of Components of Air in Relation to Diving

The composition of atmospheric air by volume is

Nitrogen	79.04 per cent
Oxygen	20.93 per cent
Carbon Dioxide	0.03-0.04 per cent

Oxygen

At sea level there is a normal oxygen tension of approximately 159 mm of mercury in the atmosphere (atmospheric pressure being 760 mm mercury). In the tissue spaces of animals the oxygen tension varies from 20-40 mm of mercury. There are three principles operating when man undertakes prolonged underwater work.

1. He breathes gases at the pressure to which he is exposed.
2. His respiratory movements must continue within their normal range and with normal frequency.
3. The gases to which he is exposed must not be noxious either at the time of exposure or on returning to normal atmosphere.

Paul Bert in 1878, a pioneer in this work, showed that oxygen tension was the factor in any untoward effect when air or mixture of N_2 and O_2 was breathed at depths. In 1899, Lorraine Smith demonstrated that animals breathing O_2 at moderately high tension over prolonged periods suffered from pulmonary damage. It was Bornstein and Stroink in 1912 who nevertheless recorded that men could breathe oxygen for 45 minutes at 3 absolute atmospheres without ill effect. In 1935, Haldane and Priestly noted that deep-sea divers supplied with air at 300 feet reported confusion and amnesia and attributed this to the raised tension of oxygen. These symptoms were shown by Behnke that same year to be due to the intoxicant effect of nitrogen at high pressure. Because of the varied nature of these findings the use of pure oxygen was limited in the Royal Navy to a pressure of 2 absolute atmospheres (Donald, 1947).

The breathing of pure O_2 was found to save a considerable amount of time. Air decompression took about 2½ times longer than oxygen decompression for same depth and period.

However, breathing pure O_2 under pressure requires care, for the effects on the

[illegible]

[illegible] even short exposures [illegible] and [illegible] was less. These [illegible] were kept in mind so that [illegible] stage ascent was considered [illegible] a diver to commence breathing [illegible] O₂ at 60-feet depth (Diving Manual)

This factor of prolonged exposure to oxygen pressure [illegible] by Haldane and McDowall (1933) who stated that divers subject to prolonged exposure to oxygen pressure equal to nearly 2 atmospheres pressure (1 40[illegible] mm Hg) are prone to attacks of pneumonia associated with poor prognosis. They stated it was exceedingly dangerous for men to work in the presence of compressed air which contained this amount of oxygen pressure.

Donald (1947) believed that the "Lorraine Smith Effect" (pulmonary damage) to divers might be disregarded and added "It can be stated with reasonable certainty that no real underwater dive will be made where lung damage will result from high tension of oxygen and at depths greater than 30 feet nervous symptoms will terminate the dive long before any pulmonary irritation occurs." He further stated that there was no cumulative effect on the lungs in oxygen diving, nor was there any evidence of the increase in the size of the heart which Italian naval medical officers and divers believed resulted.

Experiments continued and it was then considered that men at rest could breathe oxygen for at least 30 minutes at 4 atmospheres and for three hours at 3 atmospheres. Later the qualification of rest was omitted.

The Admiralty Experimental Diving Unit in April 1942 began their investigations on oxygen poisoning because of the occurrence of several cases of unconsciousness amongst divers using oxygen breathing apparatus at depths and times hitherto considered safe. Over 2 000 experiments were carried out with a large group of subjects over the period of the next two years. The striking finding was the marked variations in oxygen tolerance in a group of divers. The tolerance of each diver was found to be unpredictable and any attempt at correlation with age, height, weight, personality, smoking habit, alcohol consumption and temperature of the water all failed. The onset of symptoms of so-called oxygen poisoning showed a skew frequency distribution to time of exposure and individual variation was found over a wide range. Then it was noted that the tolerance of individual divers varied from day to day—with some subjects showing this to a greater degree than others and no cause for this varying susceptibility to oxygen poisoning could be discovered. One fact became clear that there was an increased toxicity as the depth increased. It was found that at a depth of 25 feet for a period of two hours no symptoms occurred (Donald 1947).

How the previous conclusions were arrived at in the light of these experiments is not the purpose of this paper to provide explanation. However I am of the opinion that experiments in the past were not conducted on modern critical statistical lines and conclusions were drawn on the results of too few biased returns.

It has been borne out by later experiments that the accumulation of CO_2 in the tissues was not an essential cause of oxygen convulsions. The cerebral vaso-dilatation caused by the rise of alveolar carbon dioxide may be, however, an adverse factor. Work, heat and cold are other factors reducing oxygen tolerance.

The signs and symptoms of oxygen poisoning in man resembles those observed and described by subjects experiencing the aura of idiopathic epilepsy. As in epilepsy the pattern and signs of symptoms varies within bounds of the aura, the non convulsive and pre convulsive states of that disease, and similarly evidences itself in the mode of onset of oxygen poisoning. Later, when convulsive attacks began, it was found that they lasted on the average for two minutes. If air was immediately supplied, then only one such attack occurred.

At the conclusion of the three years of experimenting, it was further noted by Donald (1947) that no adverse after effect had been recorded in any diver's neurological integrity, intellectual ability or personality.

It was believed that by a study of the electro-encephalographical findings of subjects with air hyperventilation, there might be shown an inborn instability that could be correlated with oxygen tolerance. Again there was no statistically significant correlation shown.

Donald presented the findings of Professor F. Dickens who, in 1947, described after investigations of the action of high-pressure oxygen that, "The primary effect may be inhibition of pyruvic oxidase, and that the secondary effect would be general poisoning of carbohydrate oxidation, since all known paths of carbohydrate oxidation converge at the state of pyruvates. Magnesium, manganese, and cobalt strongly protect pyruvic oxidase from oxygen poisoning in tissue slices." Donald concluded his paper by stating, "The variations of tolerance between individuals, the variance of tolerance of each individual, the variance of tolerance with work under water, all makes diving on pure oxygen below 25 feet of sea water a hazardous gamble ... the variation of symptoms even in the same individual, and at times their complete absence before convulsions, constitute a grave menace to the independent oxygen diver."

Another deep-sea hazard which divers began to experience was the syndrome of "nitrogen intoxication." When breathing air at a depth of 300 feet, that is under 10 atmospheric pressures, a diver is exposed to a partial pressure of nearly 8 atmospheres of nitrogen. With each breath this undersea worker receives eight times the quantity of nitrogen normally breathed. This higher dose of nitrogen in the blood stream acts on the brain centre and to the susceptible individual the effect is similar to that effect demonstrated by alcoholic intoxication. Nitrogen and argon per weight absorbed are just as narcotic as nitrous oxide. We already know that the amount of a gas taken up is proportional to its partial pressure. It can then be stated that most gases are poisonous if breathed at sufficient high pressure.

In the leading article (1947) it noted that hydrogen and helium are not, however, appreciably narcotic at 10 atmospheres pressure, they may well be so at 50 or 100 atmospheres. The behaviour of gases during decompression, particularly the rate at which the nitrogen in the body is given off during decompression, depends upon the nitrogen extracting stress at each particular stage. This, as in air decompression,

[illegible] the difference in partial [illegible] between the nitrogen in the blood and [illegible] the lungs [illegible] is breathed it may be assumed [illegible] partial pressure of [illegible] the nitrogen extracting stress is equal [illegible] (Diving Manual)

Carbon Dioxide

If the percentage of the CO_2 in the atmosphere increases by 10 times normal no effects are felt but should the percentage rise 100 times 3-4 per cent some discomfort may be noticed by some persons This amount of CO_2 stimulates deep breathing movements about twice as deeply as we normally breathe At a concentration of 6 per cent there is marked panting and at 10 per cent there is extreme distress At a higher percentage of the gas 17 per cent loss of consciousness occurs and at 25 per cent death will result Carbon dioxide under pressure produces an effect in smaller percentages of concentration At a depth of 33 feet 1 per cent of CO has the same effect as 2 per cent of CO_2 on the surface At 99 feet the equivalent effective percentage would be 0 5 per cent Thus the greater depths the diver descends the greater would be the effect of a small percentage of CO_2 in the helmet From analyses of air issuing from the diver s helmet it was found that about 0 014 cu ft of CO_2 in one minute at rest was produced at all sea depths and about 0 045 cu ft when the diver was at work It has been calculated that he requires 1 5 cu ft of air per minute to prevent an accumulation of CO_2 in his helmet affecting him more than 3 per cent would at the surface

In order to provide the diver with air as free from CO_2 as possible the diver often wears in lieu of a back weight a weighted cannister containing a tin cartridge filled with CO_2 absorbent

Dr Edgar End in 1937 working on the physiological problem of deep diving at Marquette University Milwaukee U S A pointed out that where the bends were not fatal and where an attack came on several hours after decompression the cause might be due to CO_2 concentration in the air breathed The property of the gas he refers to is not the poisoning characteristic in high concentrations but the action causing agglutination of the red blood stream The small clump of blood cells he stated is the embolus which occludes a blood vessel the embolus enlarges to a thrombus and then infarcts are formed This process takes a few hours to develop before complete occlusion of a blood vessel and the first symptom is pain which may lead to paralysis In some cases the symptoms were similar to those of subacute bacterial endocarditis cases where emboli of bacteria and r b c s form on an infected heart valve This may cause joint pains loss of vision and a paralysis due to occlusion of larger blood vessels End concluded that the longer the time of onset after decompression when the symptoms became manifest would favour blood agglutination as the cause rather than nitrogen bubbles

Helium

The story of helium has some interest for us This colourless odourless inert gas was discovered in 1868 by the spectroscopic analysis of the sun's spectrum when it appeared as a brilliant yellow line in the spectroscope of the chromosphere Sir

William Ram[illegible] ... disintegration of radium [illegible] issuing [illegible] the bore hole

The structure [illegible] helium air and hydrogen is [illegible] all gases being 40 per cent less soluble than nitrogen Its rate of di[illegible] times that of nitrogen Helium is monatomic and its molecular weight [illegible] therefore also its atomic weight and hence the molecular weight is 4 while that of nitrogen is 28 It was recognized that if helium could replace the 79 per cent of nitrogen which a diver breathes the decompression problem might be solved

This approach to the solution or rather attempt to ease the hazardous task of the diver as well as the reduction of the difficulties in salvage from the deep for whatever purpose war secrets treasures or more important rescue—has been this development of helium in substitution for nitrogen as the gaseous media in deep-diving rigs particularly in the U S A where it was first proposed for use in 1919 and used by the U S N in 1924

Investigations undertaken by Lieutenant Momsen showed that diving with a helium mixture in the breathed atmosphere was practicable A team of medical officers and divers demonstrated that helium was superior to nitrogen since its solubility in the blood was less than that of nitrogen Helium being 1/7th as heavy as nitrogen explained its release from the solution more rapidly It followed that decompression could take place in less time and with safety as compared with ordinary air

It was also discovered that under heavy pressure of helium oxygen a diver retained a clarity of mind which was considered a greater advantage than previously experienced with ordinary air at the same pressure One drawback however was found with the use of helium It was a better conductor of heat than nitrogen and a diver in cold water felt the cold more acutely The remedy for this was a provision of electrically heated suits of underclothes for the diver Using this rig a naval diver off the coast of Portsmouth New Hampshire descended to the sea floor a depth of 402 feet at a temperature of 35 F and worked with less discomfort with a clearer mind and without the decompression precaution and routine associated with former rigs using air under pressure at half the depth (Ellesberg 1940)

Further advances in diving brought to light new types of diving dress which permitted the diver to descend to 1 000 feet It began by the adoption of the Neufeldt and Kuhnke metal diving rig as the use of conventional flexible diving gear made it difficult for divers to work much below 300 feet At that depth a diver in ordinary gear was limited to 20 minutes on the bottom and no really effective work could be accomplished Armoured diving rigs differed in principle from the flexible types Constructed to withstand pressure at great depths and completely sealed off from the sea, the diver could breathe at normal atmospheric pressure even though at a depth of 100 fathoms Another pleasant fact was that the armoured rig would be hauled up regardless of period of dive or depth and there was no need for slow decompression or of fear of ' bends The disadvantage of this rig became apparent As a sealed bell fitted with mechanical claws and hooks actual work was thereby cut down since these gadgets could never replace the skill in the diver s hands The

other drawback was the absence of flexibility or ability to move on the wreck or sea bottom. However, as an observation media to direct operations at great depths by cranes, hoists and the placing of depth charges, the rig has its favourable points. In it the diver wore a breathing mask fitted with a soda-lime cartridge to eliminate CO_2 and a small cylinder of O_2 to use if needed. A modified version of this type of gear was used to salvage the *Egypt* in 1932, which sank to a depth of 360 feet. That same year Lieutenant Cumberti of the Italian Navy in a special diving shell descended off Porto Fino to a depth of 6[illegible]0 feet. Craig (1938) described a self contained suit, designed in 1936 on new lines, containing features which placed the art and skill of the diver on the same technical plane as that of the pilot of a jet propelled stratosphere airship.

The Craig Nohl rig attempted to eliminate the inconvenience of the old gear and to overcome known hazards of the deep by incorporating features of safeguard and comfort. The suit was built of stronger canvas than the standard dress in common use. Anti chafing trousers were added to cut down wear and tear and pockets were provided for tools. The helmet, of lighter construction than the standard, had a circular glass face plate giving full vision. The glass of the face plate was plane meniscus designed to give radial vision without distortion. The radial glass gave the same index of refraction at every point and as vision is magnified under water, this detail is important. The helmet rested on the shoulders without rocking on shoulder pads and there was no heavy breast plate. On top of the helmet a canister purified the air in the helmet, while an auxiliary air purifier was also provided. The primary canister was designed to last 24 hours of diving and the secondary for one hour. Inside the helmet there was an indicator board containing a compass, depth gauge, dials to report temperature, density of helium-oxygen mixture, amount of gas remaining in the cylinders and a watch.

There was a fitted microphone, wireless receiver and transmitter and a few other instruments. The rig was calculated to permit work at depths up to 400 feet.

A broadcast trial was attempted from the bottom of Lake Michigan on 12th April 1937 with this rig and the mechanical contrivances it contained. Craig recorded that the attempt was considered a success but the depth was only 58 feet.

Decompression Chambers

Some other improvements included submerging chambers functioning as decompression chambers for divers. They were the result of developments based on the more familiar caissons forming part of the necessary equipment on board a diving ship.

The pressure chambers were usually constructed with two locks. When the diver surfaced he entered the first lock of the chamber, the recompression chamber, where the pressure increased to prevent any more air bubbles in the blood from coming out. When the pressure was the same as the inner lock the process of decompression began. The chambers contained hot towels and warm drinks. A valuable and pleasant stimulating drink often dispensed was the mixing of equal parts of whisky and coffee for the surfaced diver (Ellesberg, 1940).

British diving developments took place by concentration on the problem of

decompression. Sir Robert Davis and his co-workers developed a special decompression chamber; when lowered some 60 feet below the sea surface one sector opened to permit the entry of the diver. The chamber was then sealed up and hauled on to the deck of the parent ship while the diver finished his decompression breathing pure oxygen. This method accelerated the escape of nitrogen from the diver's blood and decreased the time required to remain under pressure in order to avoid the "bends". Using this submersible decompression chamber a diver working 20 minutes at a depth of 300 feet could ascend in 13 minutes to 60 feet, where he entered the Davis device to be hauled up on board. Remaining in the chamber the diver was decompressed for a further 73 minutes during which time he breathed pure oxygen. In all, 86 minutes of decompression time passed before he could step on deck once more.

A modification of this diving chamber was used to great advantage along with operations by divers using the helium and oxygen rig in that excellent rescue feat of the U.S. Submarine *Squalus* crew in May 1939, accidentally sunk off Portsmouth, New Hampshire, at a depth of 243 feet. The rescue chamber was a bell fitted with decompression and compression sectors, the invention of Commander Allan McCann, operated by two divers. They controlled the machine for ascent, descent and the ballast tanks as well as the apparatus to make a water-tight vacuum fitting on the escape hatch of the submarine. This device could accommodate seven survivors at a time. On that particular operation 33 men were rescued in four descents of the bell, the last trip taking off *nine* men.

The popular appliances for submarine escape were then developed, the "Momsen Lung" and the "Davis Apparatus".

When using these appliances it was pointed out as vitally important to remember the instruction that no holding of the breath was to be practiced. To forget this would be fatal since the air pressure in the lungs might easily be increased to twice that of the sea pressure. It was explained that at the bottom of the sea bed, say 66 feet depth, the lungs filled with air at the pressure equal to that of the sea pressure. If however the man holds his breath as he rises, the water pressure about his body decreased but the air pressure in his lungs did not, and consequently the air trapped in his lungs expanded and distended the lungs abnormally and this could cause rupture of the alveoli while the capillaries had air forced into them in the nature of large bubbles. When breathing resumed nothing happened for several seconds and then the reaction started—the bubbles could reach the heart, then the brain nerve centre and these air emboli could cause death. Proper training permitted men to rise from a depth of 100 feet without any difficulty.

Research on various types of rescue chambers continued in order to establish a greater measure of security against disaster liable to occur by operations of a hazardous nature or accident to submarines. In the *Illustrated London News* of 25th December 1948 there appeared a photograph of a newly designed safety device developed by the U.S. Navy. The caption stated the device to be a "messenger buoy which is released by the disabled submarine and carried a cable attached by one end to the vessel's escape hatch and the buoy rises to the surface. A rescue chamber can be lowered on this cable to the disabled submarine."

In July 1956 in the Commons the Parliamentary Secretary to the Admiralty stated that in the light of recent progress on methods of escape from sunken submarines he was pleased to inform the House of these developments The method is by use of immersion suits by the men trapped in the submarine and they could escape in rapid succession and float to the surface through canvas trunks which extend down into the submarine from the escape hatches A system for providing purified air to the men before they escaped was specially constructed into the submarine He further pointed out that submarines would be fitted out with a hatch at each end to which a rescue bell could be attached by rescuers working on the outside of the vessel The use however would necessarily be limited as it depended on the operation of a ship containing the rescue bell Its advantage was that it could be used at greater depths than 200 feet The more extensive trials of the one man escape chamber previously intended for new construction submarines showed it to be unsuitable when relating its weight and space requirements against performance

At present all operational submarines are fitted with the more advantageous built in breathing system (B I B S)

For the past 12 years Royal Naval investigators working at the R N Physiological Laboratory at Alverstoke Hants and in the Navy s experimental diving ship H M S *Reclaim* and the submarine rescue ship *Kingfisher* have been examining the prospects of deeper and yet deeper diving by linking breathing mixtures and decompression tables in a calculated manner to achieve better results in chamber and flexible suit descents On the 28th August, 1948 it was reported in the national Press that Petty Officer Bollard R N descended to a depth of 535 feet in Loch Fyne Scotland, using a flexible type suit with a surface supplied oxygen helium mixture

Next year Boatswain s Mate H Weinsbrand U S N reached 561 feet in a dive on a simulated helium-oxygen mixture

It is gratifying to record two further notable achievements by men of the Royal Navy and particularly Lieutenant Wookey Surgeon Commander Crocker and Mr Hempleman a Senior Scientific Officer as a fitting reward for a noteworthy combined effort in establishing two world diving records

In June 1956 in Norwegian waters the divers of the *Reclaim* established a record dive in an observation chamber All the divers took part in the trials and the deepest dive was made by Lieutenant Wookey an experienced deep diver who took part in diving rescue operations in the search for H M S *Affray* when the submarine was reported missing in the English Channel in 1951

The record dive to a depth of 1 060 feet was made in an experimental chamber which could be adapted for underwater surveys The chamber with only [illegible] inch thick plating containing observation windows of [illegible] inch thickness of glass reached the depth where the estimated pressure was 30 tons per square foot on the casing

Shortly after the dive was completed the *Reclaim* signalled to its sister ship the submarine rescue bell vessel *Kingfisher*

> " The time has come old Wookey said to talk of many things
> Of chambers dives squalus dips and disengaging slings
> But when it comes to record runs *Reclaim* has you beat
> Eight hundred feet isn t deep enough we ve done a thousand feet

Matters did not rest there and, on the 13th October 1956 news reached Admiralty from the *Reclaim* again in Norwegian waters off Bergen that Lieutenant Wookey in a helmeted flexible diving suit, receiving a breathing mixture of oxygen and helium supplied from the *Reclaim* reached a depth of 600 feet establishing another world record

The chief significance of these efforts is not alone the depth reached but the experience of diving at considerable depths as a matter of routine making it possible to perform salvage operations or to bring assistance to submarines when required

With the new revised system for supplying divers with the oxygen-helium mixture there is no known depth limit for the deep diver The former method of air supply as previously noted produced a nitrogen narcotic effect which prevented the diver working at full efficiency in depths exceeding 240 feet and the oxygen content of the air is such that at just under 300 feet it reaches a toxic effect under pressure

Thus 300 feet was regarded as the outside safety limit when using compressed air The limiting factor for helium which has no known narcotic or toxic effect under pressure may well be a depth beyond that at which other factors will intervene The principal one is the decompression time aspect As oxygen in the mixture is used it has to be worked out how best to limit it to an adequate amount when a certain depth is reached The change over from air to mixture at a fixed level both in descent and ascent has to be carefully planned as the diver must be protected from too much or too little of the several gases and combinations at deep and shallow stages

From the result of this experimental work divers working from these two ships carried out normal dives to a depth of 430 feet and could work at that depth for a period up to 20 minutes with the ease comparable to that experienced at 100 feet when breathing compressed air The full problem is not by any means solved as it is a complex matter to achieve the balance of shorter decompression stages without causing risk of the bends to the diver An example of the timing involved is noted At a depth of 600 feet for a period of 5 minutes a diver must remain under gradually reducing pressure for 5 hours 38 minutes before surfacing This does not mean the diver is in the water for the whole decompression period In deep diving— surfacing applies to pressure—thus at some early convenient stage he enters the submerged decompression chamber which is lowered down to meet him The entry depth is about 200 feet and then the diver and his attendant in the chamber can be hauled inboard and decompression proceeds in safety and comfort as the pressure in the chamber reduces until normal atmospheric pressure is once again reached At the end phases of the decompression pure O_2 is breathed in as this helps to accelerate the elimination of helium

A lot of people are under the impression that the helmeted diver has been outdated by the aqualung skin diver The aqualung diver is however using an apparatus designed only for shallow diving The acknowledged experts in this form of underwater activity are the French who admit that only practised specialists should attempt a descent below 60 metres (about 200 feet) and that the average fatal limit is in the region of 80 metres (about 260 feet) From the records by Dugan (1960) of

[illegible]

[illegible]

Advances in this field are seen to speed ahead [illegible] great deal of work in underwater physiological problems—be it sea or deep [illegible] has been accomplished as a specific study. A recent step to "regularize" these [illegible] on a broader basis is likely to be achieved as a result of the First International Symposium of Underwater Medicine held at Cannes 15th–19th June 1960 organized by the "Club Alpin Sous Marin" with such notables on the committee as Messrs. Mono, Dumas, Ferrat, Gagnan and Commandants Cousteau, Tailliez, Alinat.

It is clear that the deep diver begins in the really deep descent where the aqualung diver using modern apparatus finds his limitations. It may be possible in the future to "free swim" at greater depths with self contained gear but not with the aqualung type of apparatus which is unsuited for deep work as it is without the necessary elaborate control arrangements used by the helmet diver.

Part Two—The Abyss

From Piccard's writing we can summarize the recent advances concerning underwater exploration where man is limited to two working methods. The first is free diving using an "aqualung" e.g. Cousteau-Gagnan apparatus or other modifications. This has a limitation depth factor of 44 fathoms for the experienced and expert. The second means is by an attached supply line from an attendant craft above to the diver below. If a diver wears a flexible suit which allows a fair degree of mobility and uses a helium oxygen mixture he still cannot attain more than 100 fathoms as a mark of great prowess and even then conditions would have to be very favourable.

To reach greater depths a submarine type of construction or diving bell with a strong hull is the only answer.

The desire to see the wonders of the deep sea is as old as recorded history. A correspondent in a weekly press account notes that King Alexander (356–323 B.C.) ordered the royal glass workers to design an all glass bathysphere [illegible] complete with an internal lighting system to view marine wonders. History repeated itself recently when members of the Brighton Sub Aqua Club in their efforts to perfect their own bathysphere continued experimenting with a glass reinforced plastic for the hull (Press Report 11).

For the conventional submarine the weight that the constructor can give the hull considering its thickness, friction factor and calculated depth the submarine can reach without the risk of being crushed is limited. Pietro Vassena was able to increase the range of depth with his submarine C 3 by foregoing all armament and decreasing the power of the engine.

The hull to resist the pressures of the deep sea has to become thicker and thicker, heavier than the displaced water. To sustain it two factors are significant. One is to suspend the craft or hull from a cable attachment to a parent surface vessel. The second is to have recourse to hydrostatic forces acting on a bulky element.

lighter than [illegible] right compartment [illegible] re ingenious [illegible]

Two modern depth [illegible] have been [illegible] principles. Professor [illegible] colleague Barton [illegible] suspension in their bathysphere [illegible] Professor Piccard adopted [illegible] pendent method in his bathyscaphe.

The Beebe Barton bathysphere constructed of cast iron was a sphere only 4 feet 6 inches in internal diameter with a hull thickness of 1 26 inches It had two fused quartz windows for observation with a steel cable attaching it to the parent craft Two such spheres were constructed In one of these in June 1930 the explorers reached a depth of 235 fathoms In September 1932, they reached 495 fathoms In August 1934 the sphere reached over 505 fathoms at the end of a cable attached to the supporting surface vessel the *Glodisfurd n* In 1949 Barton as controller in his cable supported benthoscope reached a depth of 750 fathoms

The dangers of this attachment method are numerous It is not difficult to calculate the cable required for weight to be carried but some additional features are very difficult to cater for The surface tender vessel is bound to experience rises and falls or the surges of pitching and rolling These movements send lateral and longitudinal waves down the cable Interactions might arise which cannot be calculated and the possibility of a localized excess of stress could easily snap the cable If this sphere was to go lower instead of to the middle depths a longer cable would increase the weight of the attachment and thought would have to be given to the use of a nylon type of cable with a resistance to stress Nylon has practically no weight in water and its elasticity can absorb the effects of shocks One considerable disadvantage of the suspended sphere is the difficulty in keeping it motionless Such motion can disturb underwater fish life being observed A sphere which shares the motion of its parent attachment will not last long near the sea bottom unless shock absorbers can be incorporated Nevertheless Beebe and Barton were the pioneers in building a submarine cabin capable of resisting high pressure and the first to open the doors of the abyss to intrepid man

Dugan (1960) mentions as a precursor of modern deep-sea exploratory devices Dr Roberto Galeazzi s butoscopic turret which reached a depth of 703 feet in 1930

The doyen of Italian submarine engineers designed the steel container turret to serve as a viewing chamber with a diver seated in a saddle mounted on a rotating frame in a bulbous top which contained 12 portholes to give him full all round vision

In 1951 a diver in the Galeazzi chamber supplied by the salvage firm of Risden and Beazley to H M S *Reclaim* found the sunken submarine H M S *Affray* in the Channel confirming an asdic contact at 276 feet deep A television unit was then used to survey the sunken vessel and estimate its situation for salvage

The apparatus was used again in the Elba operation in 1954 during the laborious efforts undertaken to trace the Comet airliner *Yoke Peter* which crashed into the Mediterranean The Comet was eventually found by an underwater television contact from the frigate H M S *Wakeful*

Piccard noted the capable observations of Carl Chun who wrote of the German Valdivia oceanographic expedition of 1898 which collected submarine fauna in

[illegible]

and furnished with portholes. The [illegible] had [illegible] and operated on the analogy of a free balloon with an out[illegible] [illegible]alled [illegible] some substance lighter than water for the return ascent wh[illegible] [illegible]ng it suspended from a large parent surface vessel.

With the assistance of the Belgium Fonds National [illegible] was built to withstand pressure up to 1 600 atmospheres—a depth of [illegible]. The problems of porthole construction and methods of passing electrical and [illegible] cable [illegible] through the hull and of dropping ballast required much study.

The Second World War interrupted this work until 1945 when [illegible] National [illegible] assistance the work re-commenced and the shape [illegible] projects FRNS 2 and FRNS 3 began. The next problem was to find the right substance for the float container of an independent undersea craft. A solid lighter than water structure would be the ideal as this would be less compressible than a liquid and lifting power would not decrease with depth of immersion. Thought was given to lithium or paraffin wax. Lithium was scarce and too much paraffin wax it was calculated would be needed for this purpose. Thus a liquid had to be chosen and a type of petrol was selected. The specifications of this petrol were that it should boil between 140 F and 176 F proving good homogeneity, that at 32 F the specific gravity should be from 0.68–0.69 and that at this temperature 35.3 cu ft of petrol could carry on the surface a load of 716 to 769 lbs. With the assistance of the French Navy in the Bay of Santa Clara off the island of São Thiago, one of the Cape Verde group, on 3rd November 1948 the trial of FRNS 2, the Piccard-Cosyns bathyscaphe, took place. After a series of mishaps the empty sphere descended to 766 fathoms with an automatic pilot.

In 1951, with some modifications and a change of ownership, the French Navy, induced by Commandants Cousteau, Tailliez and Gempp, undertook to transform the FRNS 2. The new craft was given the name FRNS 3. When this was completed the achievements in her by Commandant Houot and Pierre Henri Willm were recorded. On 14th August 1953 she descended to 6 500 feet off the coast of Provence. On 15th February 1954 a descent reached 13 287 feet off Dakar—a record dive. The device was attended in these dives by the G.E.R.S. research and diving vessel *Elie Monnier*.

Early in 1952 Piccard, not being satisfied with the work on FRNS 3, accepted an Italian and Swiss sponsorship from Trieste to design a bathyscaphe and the new *Trieste* was built on similar principles to the FRNS 3.

The *Trieste* was launched in August 1953 at Castellammare and at the end of the following month, south of the island of Ponza, some 60 miles north west of Castellammare where the depth was known to be about 1 700 fathoms, the bathyscaphe made its first real dive and touched bottom at 1 732 fathoms, where the pressure was 325 atmospheres.

Piccard (1956) also pointed the way to further oceanographic researches. He

[illegible] photographic design [illegible] beyond the [illegible] visual [illegible] which [illegible] specific gravity of [illegible] would weigh only 0.607 lbs. This bears comparison to [illegible] the same volume which would weigh [illegible] 59 lbs.

Deacon (1960) notes that the early scientific expeditions were more than geographical explorations and that science in all its aspects relating to oceanography, meteorology, geology, biology, chemistry and physics, benefited by early adventures sponsored by the Royal Society and the Admiralty.

In 1769 Joseph Banks, accompanied by seven assistants, voyaged with Captain Cook to study the Pacific regions and after circumnavigating the world returned to England in the summer of 1771. For outstanding services Cook became a Fellow of the Society in 1776 and his former associate Sir Joseph Banks became its President two years later.

An expedition to the Arctic in 1773 was initiated by the council of the Royal Society as a result of a memorial to Lord Sandwich, First Lord of the Admiralty. This voyage, under command of Captain Phipps in H.M.S. *Racehorse* with Nelson as midshipman, took the first successful deep sea soundings.

Another voyage supported by the Royal Society in 1839 was the Ross and Crozier expedition in H.M.S. *Erebus* and H.M.S. *Terror*, which completed a memorable navigational feat to secure knowledge of the Antarctic seas and of the Earth's magnetism.

The first International Oceanographic Congress sponsored by UNESCO, the International Union of Geology and Geophysics, the American Association for the Advancement of Science and the Special Committee on Oceanographic Research of the International Council of Scientific Unions (representing 35 countries) was held in the United Nations Headquarters at Lake Success, New York, in August and September, 1959. At this conference 600 oceanographers met to discuss the scientific and practical problems of the oceans.

It was reported that the U.S. congress supported a select committee recommendation that U.S. oceanographic research be subsidized to a vast sum of 200 million pounds during the next ten years. Senator Magnuson stated that "The collection of Oceanographic information may be vital to our survival." It followed that some 70 new research and survey ships were part of a plan which included a bathyscaphe and other deep-sea exploration devices that should be developed.

As we know, the problems are many and the agenda is large. However, this time joint solutions backed by firm resolve point the way to a scientific combined operation upon this vast, fascinating frontier.

The spearhead of this research in Britain is the National Institute of Oceanography at Godalming, founded in 1950 by Royal Charter. The research ship *Discovery II* is at present one of the new fitted vessels, apart from the Royal Navy survey ships, which can probe the secrets of the sea (Press Report 4).

Some of the recent work accomplished by oceanographers includes the joint

[illegible] [illegible] 1200 [illegible] [illegible] [illegible] [illegible] ... [illegible] the [illegible] [illegible] ... the [illegible] [illegible] ... [illegible] [illegible]

It is remarkable how advanced were the observations by Maury (1860) [illegible] collation of data from numerous findings of naval investigations which led him to the conclusion on deep sea currents that " Experiments in deep sea soundings have thrown much light upon the subject of undercurrents There is reason to believe that these currents exist in all or almost all parts of the deep sea

In quoting from his rules of origin and balance of currents we can appreciate the logic of his presentation of a complicated subject when he stated " It may therefore without doing any violence to the rules of philosophical investigation be conjectured that the equilibrium of all seas is preserved to a greater or less extent by this system of currents at and below the surface

If we except the tides and the partial currents of the sea such as those that may be created by the wind, we may lay it down as a rule that all the currents of the ocean owe their origin to the differences of specific gravity between sea water at one place and sea water at another for wherever there is such a difference whether it be owing to difference of temperature or to difference of saltness etc it is difference that disturbs equilibrium and currents are the consequence The heavier water goes towards the lighter and the lighter whence the heavier comes for two fluids differing in specific gravity and standing at the same level can no more balance each other than unequal weights on opposite scales It is immaterial as before stated whether this difference of specific gravity be caused by temperature by the matter held in solution or by any other thing the effect is the same namely a current

That the sea in all parts holds in solution the same kind of solid matter that its waters in this place where it never rains are not saltier than the strongest brine and that in another place where rain is incessant they are not entirely without salt may be taken as evidence in proof of a system of currents as of circulation in the sea by which its waters are shaken up and kept mixed together as though they were in a phial Moreover we may lay it down as a law in the system of oceanic circulation that every current in the sea has its counter current in other words that the currents of the sea are like the nerves of the human system arranged in pairs for wherever one current is found carrying water from this or that part of the sea to the same part must some other current convey as equal a volume of water or else the first would in the course of time cease for the want of water to supply it.

In conclusion some recent Press comments have been summarized as they indicate that an encouraging, if somewhat guarded interest is being maintained by men who desire to know more of this ancient and mysterious frontier barrier the deep sea

In the *Singapore Standard* a daily newspaper dated 25th November 1958 a Press report from Moscow noted that the Soviet Union was refitting a submarine to include television cameras search lights and equipment designed to make it an underwater laboratory capable of probing the ocean depths A Soviet Tass News

Agency [illegible] which was [illegible] scientific trip in Dec[illegible]

A Press report in the *South China Sunday Post Herald* dated 2nd November 1958 noted that American naval circles were undertaking a programme of exploration of the depths of the oceans which they term inner space. It stated that the Piccard bathyscaphe *Trieste* had been bought by the Office of Naval Research and that a refit at the San Diego naval yard was going to prepare it for the venture. Dr R. Dietz, Director of this programme for exploring the depths, is quoted as saying that man has seen more of the surface of the moon than he has the surface of his own planet, and that the Pacific sea floor has an area five times that of the moon, and further stated that evidence of geological processes of which we are not yet aware are possible discoveries. It was further indicated in this Press report that a journey to the bottom of the deepest abyss would not be considered remarkable in as little as ten years time. The events that were to take place in less than two years were certainly not anticipated then.

Dietz (1958) was one of a team of American scientists who in the summer of 1957 took part in a series of deep dives in the *Trieste* off Naples. Some 26 dives were completed to determine the suitability of the bathyscaphe for oceanographic research sponsored by the U.S. Office of Naval Research. This remarkable craft consists of a cabin, the gondola, and a buoyancy float.

The gondola is a sphere of steel 3.5 inches thick, 6 feet 7 inches diameter and accommodates two men. It weighs ten tons. The float section is 49 feet 6 inches long and has a diameter of 9 feet 6 inches. Filled with petrol it is 30 per cent lighter than sea water and carries some 25,000 gallons stowed in 12 compartments. It also has an air or water tank at each end which is of thin construction and not pressure resistant. There are orifices on the tanks which permit water to enter and this arrangement keeps the internal pressure equalized with that of the water at any depth.

The bathyscaphe dives by means of flooding the two terminal air tanks of the float chamber. As it submerges the petrol in the compartment compresses at a slightly greater rate than sea water so that some water enters the hull with the petrol floating on top of it.

The float chamber carries ten tons of ballast in the form of iron pellets which control the ascent and descent of the [illegible]scaphe. This is accomplished by magnetic means whereby the pellets are held as a mass plug at the outlet orifices. If the electric power fails the pellets will be released automatically and the vessel will rise. Electromotive power comes from batteries powerful enough to drive the [illegible]scaphe slowly in a horizontal plane. However, the range is limited to a few hundred feet.

Exterior vision is achieved by two cone shaped windows in the cabin. The windows, made of perspex, are considered superior to glass or fused quartz. Illumination outside the gondola comes from mercury vapour flood-lamps suspended from the float.

Other scientific equipment includes an electric flash camera, an echo-sounder with a range of 600 feet and an acoustic telephone utilizing the transmission of sound waves through the water, the link between the bathyscaphe crew and the escort surface ship.

In 1959 a record depth, with this device reached 18 430 feet A short news excerpt from San Diego the U S naval base appeared in the *Daily Express* of 9th January 1960 (Press Report 5) noting that on Friday 7th January 1960 the bathyscaphe *Trieste* set up a new world diving record reaching more than 4½ miles deep—24 500 feet

This was a trial run which culminated in a report of a dive on Friday 22nd January 1960 completed on Saturday 23rd January 1960 when it was announced in the *Sunday Times* of 24th January 1960 that the *Trieste* dived to the great depth of 35 780 feet i e nearly 7 miles deep off Guam in the Pacific

The original report from the *Trieste* was a recording of 37 800 feet The difference between that figure and the measurement by *Challenger* in 1951 of a depth of 35 640 feet which was confirmed by Russian and American vessels is explained by the use of an incorrect conversion factor for readings taken from the gauges in the *Trieste*

The *Trieste* was fitted with a pressure gauge graduated in fathoms and in lbs/square inch The discrepancy arose because the gauge demarcations were based on fresh-water pressures and omitted the factor of increased density at greater depth As shown earlier for the conversion of pressure readings to depth it was necessary to know the average density and gravitational attraction of the Earth Another check was carried out with the temperature and salinity measurement taken by the Russian vessel *Vityaz* to make the conversion The use of the echo-sounder method of measuring depth indirectly depends on both the temperature and salinity correction for accuracy Talhez (1954) predicted this event six years previously

This outstanding feat by Jacques Piccard son of Swiss Professor Auguste Piccard and Lieutenant Don Walsh U S N as crew of the *Trieste* is stated to have reached the sea floor of the Challenger Deep in the Marianas Trench This depth is said to be more than the lower limit credited as being the depth there by the Scripps Institute of Oceanography, and deeper than the Russian sounding of 35 640 feet in 1957

This dive is the first effort of man in reaching a depth in the sea greater than that achieved in reaching the summit of Mount Everest at 29 002 feet

It was noted that this trip down took 4 hours 38 minutes and that the *Trieste* remained on the sea floor for 20 minutes where the pressure is calculated to be 16 883 lbs/square inch

The two explorers said that when the stirred up silt settled after the impact of the sphere with the sea bed they saw live mobile objects It was also very cold down below the temperature of the sea floor being 37 4°F

Recounting this memorable experience they stated that two mishaps took place at about the half way mark which caused them to lose control for a while This was regained on the sea bed on the downward journey and again occurred on the return journey upwards The trip back to the surface took 3 hours 27 minutes

The crew of two spent nearly ten hours in the small compartment amongst storage batteries, gas cylinders and instruments in a cabin temperature stated to be a damp 45°F

Philip Deane reporting from Washington on 23rd January 1960 on the U S naval communique's data of the record diver (Press Report 7) stated that the purpose was to demonstrate that the U S possessed the capability for manned exploration of the sea even into the deepest part of the sea floor

The preparation for the dive took two years of research planning in which full knowledge of material stresses and temperatures were electronically computed to make certain that the design and modification of the *Trieste* was up to analytical requirements.

The dive commenced before dawn in order to give time for the bathyscaphe to surface in daylight and in case of difficulty that it might be found if carried away from the submerged areas by underwater currents. Sonar Radio contact was maintained with attending vessels on the surface to a depth of 3 000 feet. The position given was 11° 19.7 North 142° 12 East. A practical reason hinted at was that this exploratory investigation might also provide dumping areas for future radioactive wastes which are bound to mount in quantity in years to come. Presence of deep-sea ocean currents would make this depositing a risky issue.

During the lengthy passage and their brief stay on the sea floor they studied light penetration, deep sea visibility, transmission of sound, gravity readings and the marine geology of the Trench.

It was reported in the Press in February 1960 that the Civil Lord of the Admiralty was asked in the House why the bathyscaphe was declined when offered by Professor Piccard to his department. Mr Orr-Ewing stated that the Admiralty after careful consideration of the offer in 1955 felt they would not be justified in collaborating in and financing the operation of the bathyscaphe in the Bermuda area in view of the world-wide oceanic investigation undertaken through our own survey ships and the National Institute of Oceanography.

The questioner persisted and pointed out that as no charges other than running and development costs were involved would a repeated offer be accepted. The Civil Lord said that the matter would be looked into (Press Report 9).

It is worth a thought to speculate about future undersea travel, whereby submarine liners could travel at 30 fathoms deep using an echo sounder of ultrasonic waves for detection of near horizontal surface or deeper objects and containing an electronic brain as pilot to neutralize the movement of eddies at origin along the hull surface to cancel resistance, simulating the dolphin's progress. It could then speed along at 60 knots or more and effect a smooth, effortless ocean crossing every time at any season, disregarding surface frenzy of storms, swells and waves. This is all to come, and it will, when marine scientists are encouraged and progressive governmental scientific groups take up the incentive with research projects.

A tremendous advance by practical evidence of technical skill was achieved when Admiral Rickover's brilliant efforts culminated in the launching by the American President's lady at the Electric Boat Company yard in Groton, Connecticut, on the 21st January 1954 of the first atomic-powered submarine the *Nautilus*. Several sister ships are presently in operation and we can expect remarkable achievements in fields of undersea exploration for each new class of this craft. An intrepid naval commander undertook the "North-west Passage" under the north polar ice cap from the mid Pacific to the western shores of Europe in the *Nautilus* in August 1958.

New ventures with these powerful and capable vessels were planned, unlimited by the zeal of Navy men and restricted only by the functional limits imposed on the new electronic and other scientific devices under trial and test.

At present writing the recent feat of superb navigation undertaken by the largest

nuclear powered submarine the U S S *Triton* to repeat the round the world route taken by Magellan (1519–1522). *Triton* accomplished the mission and the remarkable craft accomplished this almost entirely submerged

The voyage began on 16th February 1960 when *Triton* submerged off Long Island New York whence she proceeded south east to St Paul Rocks round the Horn and across the Pacific to the Phillipines then through the Macassar Strait across the Indian Ocean to the Cape of Good Hope and north west again to the mid Atlantic, St. Paul Rocks where she arrived on 25th April 1960 to complete the circumnavigation of Magellan She then travelled across the Atlantic to Cadiz as the tribute to the earlier navigator and returned to full surface for the first time in 84 days off Rehoboth Beach Delaware on 10th May 1960 a trip underwater of 41 519 miles successfully plotted by the ship s inertial navigation system

Captain Edward Beach her commanding officer on arrival at Delaware was flown to Washington to receive the congratulations of President Eisenhower not only to himself and his gallant crew but to a mighty vessel her designers planners constructors and maintainers

Some excellent photographs of the personalities and action studies in the submarine were contained in the *Illustrated London News* of 21st May 1960

A B B C television news report on 27th May 1960 contained the information that the Office of the U S Naval Research Department at La Jolla California demonstrated a remote controlled undersea exploratory device a tractor-like vehicle equipped with grappling and sampling gadgets and contained a television unit The vehicle was stated to be capable of tracking out to sea for a distance of five miles and could function at a depth of 20 000 feet Who can doubt that the serious study of this frontier of the Abyss is not without the apparatus of research ingenuity if not scale as that required for probing outer space

By this stage it is not surprising if the reader is led to repeat that wonders never cease—as material on virtually day-to-day advances appears in popular magazine articles and national newspaper press reports on these activities

On the B B C television programme Tonight on 13th June 1960 Jacques Cousteau s " undersea saucer was shown being put through its paces off the French Mediterranean coast This new independent underwater exploration device containing a crew of two weighing 3½ tons moving about 3 knots an hour under jet propulsion was seen to glide over the sea bed. The commentator noted the craft kept submerged by ballast which could be released to assist surfacing and reached a depth of 1 000 feet In fact it was described as an " inner space ship

The programme of developments accelerating so rapidly lends one to suppose that as in aircraft and warship production by the time a project leaves the drawing board for production another bigger better and more novel idea is under way

The Times correspondent in New York reported on 28th July 1960 that the most recent U S N nuclear attack submarine *Sea Dragon* of 2,360 tons set off on 1st August, 1960 from the U S naval yard at Portsmouth to navigate submerged the east to west Atlantic crossing under the North Pole This was the first attempt of the journey in this direction as previous attempts by *Nautilus* *Skate* and *Sargo* were the other way

An [illegible] co-operation in the field [illegible] has recently been completed [illegible] vessels taking part in a quest to locate the cleft in the ridge which forms the Arctic basin were from Britain (three ships) Norway and Germany (two ships each), and Russia and Iceland (one ship each) The division in the ridge was found between Iceland and the Faroes and through this the water near freezing point spreads from the Arctic to the Atlantic floor

This information has a direct bearing on problems associated with fishery harvests meteorological activities disposal of radioactive wastes and such matters as the further knowledge about migration of eels

To arrive at that finding took the ships a month working courses ten miles apart and by measurement of the bottom currents, sea water temperature density and salinity

The correspondent points out that this Arctic outflow precludes the suggestion that the Arctic basin could be used as a disposal area for atomic wastes (Press Report 12)

The Times correspondent in Washington reported a demonstration off St. Petersburgh, Florida where the depths of the sea were regarded as a depository of parcels a left luggage on a gigantic scale Expert observers from the defence department, other government departments, oil companies and various public authorities examined the possibilities of rubberized nylon tanks being used to store fuel water medical supplies, food clothing, machinery and munitions and could remain anchored to the ocean bottom in good condition out of harms way

The advantage over present means of stowage is stated to be in the assurance that materials could be protected from atomic radiation infection vermin temperature changes humidity and that safety from enemy attacker reconnaissance had to be considered

The interest by oil firms stems from the use this method could be put to at off shore drilling areas where the shallow water does not allow the approach for loading super tankers

The makers claim the nylon containers holding about three tons of fuel could be towed in a chain link on the surface of the sea or below it and when emptied these containers could be rolled up and transported to base to repeat the process (Press Report 14)

Dr W Kramer a former German missile scientist now working in the U S A developed a flexible rubber skin which can be attached to submarines or the submerged part of ships hulls to effect the maintenance of laminar flow of water under the craft The means of achieving this is by placing on the body rows of short rubber studs The space about the studs between the rubber skin and the hull is filled with a fluid so that the skin yields slightly to local variations in pressure This dampens the little vortices that are the feature of the usual turbulent flow

The idea noted in an article in *The New Scientist* of 11th February 1960, followed from observations on the swimming habits of dolphins It was known that the muscular power of the mammal was not sufficient for them to achieve the speeds recorded unless their resistance to motion was less than that of a rigid body of similar shape It was then assumed that the creatures were able to maintain a laminar flow

[illegible] Kramer [illegible] the dolphin's sk[illegible] rubber Tests that resulted record[illegible] 50 per cent reduction [illegible]

It was appreciated that there would be many practical [illegible] condition of this "skin" under serviceable conditions which [illegible] temperature and salinity changes, fouling by marine growths and organisms and docking problems

Finally, a report in *The New Scientist* of 21st July 1960 noted that an International Conference on Oceanographic Research recently met at Copenhagen was attended by delegates from 37 countries and 13 international organizations This meeting was held with the object of conjoining world wide efforts to unravel the mysteries of the sea and to utilize the abundant resources

Plans have been drawn up for the formation of an Intergovernmental Oceanographic Commission with an office within Unesco The proposal for this will arise after the general conference of Unesco in November 1960

This new body it is anticipated will function to co-ordinate research projects and become a world centre for such information as it has been the contention of marine scientists that national efforts are minor in relation to the size and complexity of the tasks requiring solution

A further step is envisaged in the plan for the commission to rig out and operate an international research vessel In the first stage, a small vessel of some 1 000 tons is contemplated, primarily for training student scientists in eastern waters where no continuous research is being carried out at present The second stage recommends the construction of a larger vessel fitted with advance equipment beyond the scope and finances of most nationally operated research ships

Additional links the commission anticipates are with the International Atomic Energy Agency over persistent matters of disposal of radioactive wastes at sea and with the Food and Agricultural Organization to advise on means of increasing food supplies from the sea

The course as we observe it is set and it may be that civilization's foster parent, the sea could be the means of ensuring our further peaceful survival on Earth in unity

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TABLE OF LINEAR CONVERSIONS

1	1 inch	2 54 centimetres
2	1 foot	30 48 centimetres
3	1 yard	0 91 metres
4	1 metre	39 37 inches 3 28 feet 1 09 yards
5	1 fathom	6 feet 1 83 metres
6	1 kilometre	0 62 miles
7	1 mile	5 280 feet 1 760 yards 1 61 kilometres

Reviews

[illegible] Clinical Medicine. Edited by John W. Todd, M.D. [illegible] Bristol: [illegible] Medical Publishing Company Ltd. Price 5 gns.

This [illegible] book. In its opening pages Dr. Todd seizes [illegible] and [illegible] sweep away [illegible] medical dogma. [illegible] theories [illegible] causation and treatment of certain diseases are exposed [illegible] to the [illegible] before one has reached p. 9. Much of his writing [illegible] increased [illegible] many diseases [illegible] attributed to the stress and strain [illegible] may be [illegible] the mundane in fact [illegible] we stress and strain [illegible] even [illegible] hundred years ago worked [illegible] long hours in [illegible] very small wage and when neurotic [illegible] told (which he often was) [illegible] Lord [illegible] help him. The citizen of today is apparently much better [illegible] though [illegible] is often said to suffer much stress and strain [illegible] other contexts he [illegible] that he is cosseted from cradle to grave by the Welfare State.

More controversial—though thought [illegible] by many [illegible] Many conditions [illegible] though invariably fatal are susceptible to treatment which will prolong life. Should every step be taken to keep them alive as long as possible, or should they merely be given symptomatic treatment and be allowed to die in peace? Some physicians [illegible] to stop their repeated blood transfusions which are keeping the victim of acute leukaemia alive. This attitude is understandable, but there are surely many occasions in which the right and kind course is to give the patient analgesics and hypnotics, make him as comfortable as possible and let him die.

Again most of us will find this frank opinion not unwelcome. The valuable physical signs are those which are striking and whose characteristics can be agreed upon by any number of observers. The very fact that one observer is unable to confirm the presence of a sign discovered by another should always give rise to doubt as to its reality. The minutiae of physical signs—the roughening of the first heart sound, the increased area of splenic dullness, the equivocal plantar response, the slight murmur—are mainly of more than doubtful significance and should usually be ignored.

The book, which by present day standards of a textbook of medicine, is small, is divided up into the conventional compartments. Dr. Todd writing the major part and being most competently supported by nine other physicians. Amongst their contributions the reviewer found Scadding's chapter on respiratory diseases outstanding.

There is no section on dermatology (the reasons for which omission are may be a little tenuous) nor are [illegible] of the psychological disorders as such discussed—Dr. Todd is however constantly aware of the relationship between "Psyche and Soma." The book is well produced, the illustrations and X-ray reproductions are excellent, the price (5 gns.) in these days of inflation is not too alarming. Any adverse criticism? Well yes, the index. It seems inadequate in a book of this size and price. You will not find hamstrings or extrasystoles or even the word varus, and while a fairly rare syndrome like Klinefelter's gets a mention, the more frequent and more familiar Kimmelstiel-Wilson is missing.

An enjoyable, up-to-date and pleasantly unusual textbook of medicine, which will surely make its mark amongst its many competitors.

E. D. C.

Clinical Haematology. By Robert Duncan Eastham, B.A.(Cantab.), M.D.(Cantab.), D.C.P., Dipl. Path. Pp. 158. Bristol: John Wright & Sons Ltd. Price 15s. 6d.

The author has contained within a pocket size volume a wealth of information essential to both the clinician and the haematologist. Though actual techniques are not described the book is essentially practical. Not only are all haematological values, both normal and abnormal, given, but the conditions giving rise to these values are listed and the lists are frequently accompanied by succinct and remarkably clear discussions of the various factors involved. There is an excellent section on "Blood Clotting and Transfusions." This is a reference book rather than a textbook.

F. W. E.

A Guide to Cardiology. By Leonard and Gelm. Pp. xii + 257. Illustrated. London and Edinburgh: E. & S. Livingstone Ltd. Price 27s. 6d. + 1s. 6d. Home Postage.

This book is up-to-date, small and yet most comprehensive and one feels it will quickly become extremely popular—it is a new entry.

The style is easy and readable, the book is light to the hand and elegantly produced with good X-ray pictures and clear-cut electrocardiographs.

The section on electrocardiography is lucid and well illustrated and the reviewer also enjoyed the traditional, but most important, section on cardiac examination and the assessment of what one sees and hears.

The [illegible] and importance of early diagnosis of congenital heart disease are [illegible] in a [illegible] chapter on the diagnosis, prognosis and treatment of the various conditions and Ischaemic heart disease gets the full attention which it unquestionably merits.

This book seems to be of outstanding value at its very modest price and can be unreservedly recommended to all naval physicians. E. D. C.

A Guide to the Nervous System. By John Gibson, M.D., D.P.M. Pp. 108. Illustrated. London: Faber & Faber. Price 12s. 6d.

This small book is intended to give the student of nursing an acquaintance with the anatomy and physiology of the nervous system. In a short 103 pages Dr. Gibson gives a good outline of the structure and functions of its central, peripheral and autonomic divisions.

As an introduction to the subject it is good and simplifies a complex system in a way that would enable a student to get a good grasp of the essentials.

The text is clear and easy to follow; it is also well illustrated with diagrams, which is most important in obtaining an understanding of the inter-relationship of the various parts of the system.

This book might well be of value to the Second M.B. student to give an overall view of the subject before undertaking more detailed study. J. J. B.

A Textbook of Psychosexual Disorders. By Clifford Allen, M.D., M.R.C.P., D.P.M., Consultant Psychiatrist in charge of the Psychiatric Department, Dreadnought Seamen's Hospital, Greenwich; Consultant Neuropsychiatrist to the Ministry of Pensions. Pp. xii + 40?. London: Oxford University Press. Price ? gns.

The author has been renowned for many years as an authority on psychosexual disorders and particularly for his renunciation of therapeutic pessimism in this field. This book was developed from *The Sexual Perversions and Abnormalities* which was first published in 1940. The change in title accords with the author's view that the moral condemnation implied in the word "perversion", although perhaps legally and religiously apt, should have no place in the psychiatrist's vocabulary. Instead he uses "paraphilia" as a generic term for psychosexual disorders and describes the patients as "paraphyliacs" or "paraphiliacs" in despite his labels, "perverts".

Unfortunately the text is marred by loose writing of this sort. One can easily pick holes in a classification of psychosexual disorders but why should the author distinguish the sexual object from the stimulus and regard incest and rape as disorders of the object? A graph and a table after Kinsey are not mentioned in the text and are incomprehensible to the reviewer. A schema devised to show the relationship between physical, sexual and psychiatric anomalies and the author's conceptions of the psychopathology of schizophrenia and involutional depression would be regarded by most psychiatrists as quaint. The seeking of an elderly person as a sexual object would possibly be better called "Gerontophilia" than "Gerontosexuality", which suggests merely sexual activity by the aged, and one is startled by the sudden unannounced transition from this subject to a digression on the connections between "perversions" and neurosis, psychosis and suicide. The section on conditioning as a method of treatment is muddled by admixtures of persuasive and environmentally manipulative measures. "Pre-puberal" and "post-puberal" must be original variations of spelling.

There is much repetition. The normal sexual act is described twice and the reader is told many times of the author's opinions about the corrupting behaviour of choirmasters, clergymen and scoutmasters, about the disastrous results of imprisonment of homosexuals and about the misuse and not infrequent failure of oestrogens as a means of suppressing male sex drive. References from one page of the book to another are in numbers and references to other authors are given at the end of each chapter, whereas they would surely be better collected in one list and left out of the index, which is by no means faultless: on the pages mentioned alongside Dr. "Curran, D." one finds mention of "Curran, F. J." while Professor Desmond Curran, despite his eminent writings on sexuality, is omitted from the text.

The author is psychoanalytically orientated but eclectic, despite which his dogmatism characterized by many phrases such as "It was wrongly suggested by the Wolfenden Committee ..." and "The senseless routine of military life ..." is not easy to swallow. Nor can one accept uncritically the statement that a man "... became so obsessional that only prolonged treatment saved him from developing schizophrenia".

The role of affect is surprisingly not included in rather lengthy lists of factors which may increase or diminish the sexual drive. And, although this is a 1962 textbook, the Mental Health Act of 1959 has not found its way into the medico-legal section.

The author's contention that the new born child has no emotion but hate in its repertoire would interest Mr. John Osborne.

No attempt at statistical finesse in the evaluation of therapeutic endeavour will be found here and of the many accounts of patients treated by the author almost every one ends in gratifying success.

The literary style reads pleasantly and is always entertaining, holding the attention from one chapter to the next. Historical, sociological and ethnological descriptions vividly embellish the psychiatric and physical material to form a comprehensive and important work which, by the unavoidable cliché, should be on every psychiatrist's shelf. The criticisms advanced above are given in the spirit that the book merits close scrutiny and serious consideration. G. G. W.

DIABETES MELLITUS IN THE TROPICS By J A [illegible] M C M D F R C P E Pp x+294 London and Edinburgh E & S Livingstone Ltd Price 17s 6d—1s 3d Home Postage

It is quite interesting how the pattern of tropical medicine is changing and in recent years the growing tendency to consider either the medical problems of separate areas of the tropics or the studies of individual diseases is increasing. This book on diabetes is a good example and brings home very forcibly the magnitude of this problem in tropical communities

The book is carefully arranged and well balanced. It is obviously the result of conscientious investigation and generous consultation. Diabetes is studied systematically the first chapter outlining its significance in the tropics and giving convincing figures to support it. This is followed by a series of chapters starting with aetiology and concluding with treatment while in conclusion a chapter is devoted to studying what should be done in the future. Of particular value however are the series of appendices which give lists of diets appropriate to the natural food resources of the various parts of the tropics. It is undoubtedly a book which must be of exceptional value to the general practitioners working in tropical countries

It is of convenient size easy to read to the point and contains a useful list of references for the inquisitive. S M

CLINICAL METHODS IN TROPICAL MEDICINE By Brian Maegraith M A M B, B Sc D Phil F R C P (Lond) F R C P (Edin) and C S Leithead M B Ch B D Obst R C O G D T M & H Pp ix+544 Many plates and photographs London Cassell & Co Ltd Price 30s

How refreshing to find a compact little textbook which breaks away from the stereotyped pattern of its predecessors and presents tropical medicine as an art rather than a science. It must give great confidence to the young physician approaching tropical practice in that it guides his training on familiar lines into a new field. The approach to tropical medicine is through the patient rather than the disease and this is by and large achieved system by system

The book is easy to follow and the authors are to be congratulated on this new and welcome approach S M

THE BRITISH NATIONAL HEALTH SERVICE—Friend or Frankenstein By Donald McI Johnson M B B Ch M A M R C S L R C P Barrister-at-Law Pp 234 London Johnson Publications Ltd Price 21s

Having read this somewhat critical review of the National Health Service one is tempted to feel sorry for the author who gives the impression of having a very big chip on his shoulder. It is critical rather than constructive and although no one can deny the truth of many of the instances of misuse of the Service one wonders whether this is not the voice of a dissatisfied minority. In spite of all the adverse comment one is conscious that the majority of general practitioners one meets are relatively happy well clothed, well fed and driving about in quite comfortable motor-cars

The book is undoubtedly well written and challenging, and not without its moments of humour. It is not an expensive book and provided it is read without prejudice and accepted at its face value it is worth a place on the library shelf S M

We acknowledge with thanks receipt of the following publications

Acta Medica et Biologica Annali Di Medicina Navale Annales Medicinae Internae Fenniae Annals of Tropical Medicine and Parasitology Australian and New Zealand Journal of Surgery Australian Journal of Experimental Biology and Medical Science British Medical Bulletin British Medical Journal British Journal of Surgery Bulletin of the World Health Organisation Chinese Medical Journal Gunma Journal of Medical Sciences Guy's Hospital Gazette Harvard Medical Digest International Review of the Army Navy and Air Force Medical Services Journal of the Irish Medical Association Journal of the Royal Army Medical Corps Journal of the Royal Naval Scientific Service Kyushu Journal of Medical Science La Medicina de Reserve Middlesex Hospital Journal Military Medicine Montreal Medical Nagoya Journal of Medical Science Proceedings of the Staff Meetings of The Mayo Clinic Revista Medica del Hospital Colonia Mexico Revista Medica Militar Revista De Medicina Sperimentale E Speziale Sheffield University Medical Society—North Wales Studies Alive Suomalaisen Tiedeakatemian Akatemiallinen St Thomas's Hospital Gazette The Blood Way Tohoku Journal of Experimental Medicine Tropical Diseases Bulletin University of Birmingham—Thirty Second Annual Report Yokohama Medical Bulletin

News of the Service

OBITUARY

Surgeon Rear Admiral H. S. BURNISTON, *C.M.G.*, died on 1st May 1962. He was born on 16th October 1870 and qualified M.B., B.S. in 1892, M.R.C.S.(Eng.) and L.R.C.P.(Lond.) in 1893.

Surgeon Rear Admiral Burniston entered the Royal Navy as a surgeon on 16th May 1894. He was promoted Staff Surgeon on 16th May 1902, Surgeon Commander on 16th May 1908, Surgeon Captain on 30th June 1922, and was placed on the Retired List (age) with the rank of Surgeon Rear Admiral on 16th October 1925.

He was awarded the *C.M.G.* for valuable services rendered during the First World War (*London Gazette* 1st January 1919).

Surgeon Rear Admiral Robert John MacKEOWN, *O.B.E.*, died 18th April 1962 at the age of 90. He was born on 8th September 1871. He graduated in medicine at the Royal University of Ireland in 1893 and entered the Royal Navy as a Surgeon on 15th May 1895. After obtaining his Diploma in Public Health at Aberdeen University in July 1896, he maintained a keen interest in the problems of naval hygiene throughout his Service career. He was promoted to the rank of Staff Surgeon on 15th May 1903 and Surgeon Commander in 1909. He served in H.M. Ships *Benbow* and *Emperor of India* during the First World War and on 17th July 1919 was appointed an officer of the Order of the British Empire in recognition of his war services. On 31st December 1922, he was promoted to the rank of Surgeon Captain and after a period of service at the Royal Naval Hospital Chatham, he retired in the rank of Surgeon Rear Admiral on 18th June 1926.

Surgeon Captain C. M. R. THATCHER died on 13th April 1962. He was born on the 13th May 1888 and qualified as an M.B., B.S.(Edin.) in 1911.

He entered the Royal Naval Medical Service on 24th November 1911 as a Surgeon Lieutenant. He was promoted Surgeon Lieutenant Commander on 24th November 1919, to Surgeon Commander on 24th November 1923 and to Surgeon Captain on 30th June 1935.

Surgeon Captain Thatcher was placed on the Retired List (age) and re-appointed on 30th May 1945. He was Released Class "A" on 22nd July 1946.

Surgeon Captain H. B. PARKER, *C.B.E.*, *D.S.C.*, died on 29th April 1962. He was born on 13th June 1886. He qualified M.B., B.S., M.R.C.S., L.R.C.P., D.T.M. & H. He entered the Royal Naval Medical Service on 5th April 1914 as a Surgeon Lieutenant and was promoted to Surgeon Lieutenant Commander on 3rd April 1920, Surgeon Commander on 3rd April 1925 and to Surgeon Captain on 30th June 1936. He was placed on the Retired List (age) on 13th June 1943 and re-appointed. He was released Class "A" on 3rd September 1946.

Surgeon Captain Parker received the *D.S.C.* for exceptionally good work as Medical Officer of *Nelson* Bn. R.N.D. in Gallipoli 1918 (*London Gazette* 18.6.1918) and was awarded the *C.B.E.* in the New Year Honours List (*London Gazette* 1.1.1944).

Surgeon Captain Edward Oliver Bamford CARBERRY died on 25th May 1962. He was 90 years of age.

He qualified as M.B. and B.S. (University of Ireland) and entered the Royal Naval Medical Service on 8th November 1898 as a Surgeon and was promoted to Staff Surgeon on 8th November 1906 and to Surgeon Commander on 8th November 1914.

Surgeon Captain Carberry was awarded the *O.B.E.* (Military) for service rendered during the First World War (*London Gazette* 31.12.1918).

He was placed on the Retired List (age) with the rank of Surgeon Captain on 16th May 1923.

Surgeon Captain Claude Dumarell COODE died on 2nd June 1962. He was born on 6th December 1909.

He qualified B.M., B.Ch.(Oxon.) 1936, M.R.C.S.(Eng.), L.R.C.P.(Lond.) and F.R.C.S.(Edin.).

Surgeon Captain Coode entered the Royal Naval Medical Service on 7th January 1938 as a Surgeon Lieutenant and was promoted to Surgeon Lieutenant-Commander on 7th January 1943, Surgeon Commander on 31st December 1951 and to Surgeon Captain on 31st December 1960.

J.R.K. writes:

After a trying illness borne with great fortitude Surgeon Captain Claude Dumarell Coode died in the London Hospital on Saturday 2nd June, at the age of 52.

He was brought up in Stroud, Gloucester, the son of a well known general practitioner and went to Magdalen College, Oxford, where he graduated B.A. with honours in physiology. He proceeded to the London Hospital where he took the M.R.C.S., L.R.C.P. in 1935 and B.M., B.Ch. the following year. He was Casualty Officer and House Physician at Poplar Hospital and House

Surgeon at the London [illegible] the Medical Service of the Royal [illegible]. He was elected F R C S (Edin) in 194[illegible]

Among his appointments [illegible] the Second World War were H M S [illegible] R N [illegible] Quarters Reykjavik, and R N H [illegible] where he served on the surgical [illegible] he served as Surgical Specialist at the R N H Portland and at Simonstown and [illegible] Senior Medical Officer in H M S [illegible] He joined the staff of R N Hospital Malta [illegible] capacity in January 1959 He was promoted Surgeon Captain in December 1960 [illegible] at Bighi as Senior Medical Officer until the summer of 1961 He returned to Haslar as Senior Surgical Specialist in September of the same year and had only been in this appointment for a few months when his illness overtook him

Alfie Goode will be very greatly missed by a wide circle of friends and colleagues both within and outside the Service As a surgeon he was highly respected by all and his diagnostic acumen was held in the highest regard He was widely read and had through the years kept up his surgical connections in London not only to his own benefit but to that of his patients and his juniors as well His forthright manner belied a kindness and understanding which brought comfort to innumerable patients and their relatives He took a keen interest in the welfare and training of the sick berth staff and many will testify to the friendly help or encouragement they have had from him

Of Alfie much could be written He had many interests widely varied and in everything he was an enthusiast As a raconteur he was a legend He was a keen yachtsman and sailed his *Albacore* with the zest and enthusiasm of one of half his years

His friends and colleagues deeply mourn his loss His happy family life was one of the sources of his strength and to his wife and two sons we extend our most sincere sympathy

Surgeon Lieutenant Malcolm Milton MELROSE died on 21st April 1962 in Southern Rhodesia He was born on 27th December 1887 He qualified as M R C S (Eng) and L R C P (Lond) 1911 and entered the Royal Naval Medical Service as a Surgeon Lieutenant on 24th November 1911

In April 1912 he was awarded a Gold Medal specially noted for obtaining the highest marks at Royal Naval Hospital Haslar examination

He was placed on the Retired List (invalided) on 24th March 1919

HONOURS AND AWARDS

Knight Commander of the Order of the British Empire

Surgeon Vice Admiral Sir William Robert Silvester Panckridge C B Q H P M R C S L R C P

Companion of the Bath

Surgeon Rear Admiral J Mansell Reese O B E Q H P M R C S L R C P D P H

Commander of the Order of the British Empire

Surgeon Captain W J Forbes Guild Q H S M D F R C S (Edin)

Officer of the Order of the British Empire

Surgeon Commander (D) J Hunter L D S

Member of the Royal Victorian Order

Surgeon Commander D G Dalgliesh O B E M R C S L R C P

Gilbert Blane Medal 1962

Surgeon Captain F D Caldwell M D M R C P

HIGHER QUALIFICATIONS

Surgeon Lieutenant R W K Rogers—D I H March 1962
Surgeon Lieutenant-Commander P H Lovell—D M R D March 1962
Surgeon Lieutenant J R Steele-Perkins—D C H March 1962
Surgeon Lieutenant G D Lister—D Obst R C O G April 1962
Surgeon Lieutenant D A Lammiman—D Obst R C O G April 1962

PROMOTIONS

To Surgeon Lieutenant Commander—A H Tooley M B L R C P F R C S J W Richardson M B B S T P Oliver L M S S A D R B Mends M B Ch B E H Sims M B Ch B J B Drinkwater M B Ch B F R C S (Eng) G J Milton Thompson M A M B B Ch M R C P (Lond) L C Banks M B Ch B T R W Hampton M B B Ch P C Follord M B B S D C Beckingham M B B Ch M R C O G P J Truesdale M B Ch B C N Barnes M B B Ch T L Fallowfield M B Ch B M Sc W M Hollyhock M B B Ch E F P Barnard M B B S M R C S L R C P D M Ackery M B B Ch R J Morrow M B B Ch J W Alderson M B B S D W D Evans M B B Ch R J W Adamson M B B S M R C S L R C P D Obst R C O G J B Gill M B B Ch J R Steel M B B Ch D A F Shephard M B B S D A B W K Rogers M B B S D Obst R C O G D I H C W Chapman M B Ch B A McEwan L R C P & S L R F P & S P S Browne M B B Ch
To Surgeon Lieutenant Commander (D)—R C R Eve L D S P C Wrigley L D S B H Black B D S D A Coppock B D S C J Wilkinson L D S G D Sharpe B D S L D S I O Ledbetter L D S

RE-ENTRY

Surgeon Lieutenant D H Elliott M B B S D Obst R C O G

TRANSFERS TO THE PERMANENT LIST

Surgeon Lieutenant Commander D G Bluett M B B S M R C S L R C P D Obst R C O G
Surgeon Lieutenant K H McCrath M B B S M R C S L R C P D Obst R C O G
Surgeon Lieutenant R C Telfer, M B Ch B

RETIREMENTS

Surgeon Commander W H C Watson M B B Ch M R C S L R C P 30 4 62 (Own Request)
Surgeon Commander The Hon A G Guthorne Hardy M B Ch B, 10 8 62 (Age)
Surgeon Lieutenant Commander B W K Rogers M B B S D Obst R C O G D I H 17 7 62 (Released from Short Service Commission)
Surgeon Lieutenant T J Phillips, M B Ch B 15 4 60 (Own Request)

RELEASED ON COMPLETION OF SHORT SERVICE COMMISSION

Surgeon Lieutenants I S Begg R C Clark W D S Blake J W S Lee J F Whitaker M V McCabe
Surgeon Lieutenant (D) R Havekin

WARDMASTER OFFICERS

Member of the Order of the British Empire

Wardmaster Lieutenant Commander J A E Lihou
Promoted to Acting Wardmaster Sub-Lieutenant—S B C P O E S Taylor
Confirmed in the Rank of Wardmaster Lieutenant—H Grundy

QUEEN ALEXANDRA'S ROYAL NAVAL NURSING SERVICE

Miss A A E Burman A R R C to Principal Matron 15 6 62
Miss M E Myers A R R C to Principal Matron (Tutor) 18 6 62
Miss N H Glew A R R C to Principal Matron 2 7 62
Miss H M Scott to Superintending Sister 11 4 62

TRANSFER TO PERMANENT SERVICE

Miss S M Hayes Senior Sister 24 5 62

RETIREMENTS

Miss Helen Moore *C B E* Q H N S R R C Matron-in-Chief 11 8 62 (Age)
Miss N M Willoughby R R C Principal Matron 18 6 62 (Age)
Miss S M Houston A R R C Superintending Sister 30 4 62 (Marriage)

NAVAL NURSING AUXILIARY OFFICERS

RETIREMENT

Miss V E Porter A R R C 1 5 62 (Own Request)

ROYAL NAVAL RESERVE

Promoted to Surgeon Lieutenant-Commander—T R Roddie M B B Ch B A O M R C O G 18 5 62 Seniority 18 5 61 and P G Oliver M B B S M R C S L R C P D P H D I H 1 5 62

ADMIRALTY FLEET ORDERS—1962

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Notice

The Editor invites medical officers to send in original papers on professional subjects travel personal experiences, etc. Items of news and matters of interest to the naval medical service will be welcomed from ships and establishments on home and foreign station. Notices of births marriages and deaths are inserted free of charge to subscribers.

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The JOURNAL is published quarterly four numbers comprising one volume.

Articles and communications may be sent to the Editor at any time. **They should be clearly written or, preferably, typed and sent in duplicate** to The Editor, R N Medical School Alverstoke Hants.

Subscriptions

For R N and R N R medical personnel on the active or retired list and for Consultants to the Royal Navy the subscription is 20s per annum (postage included) payable on 1st January of each year. Single copies 5s.

For dental officers in the above categories the subscription is 10s per annum (postage included). Single copies 5s.

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THE EDITOR

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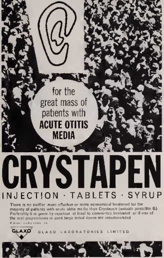

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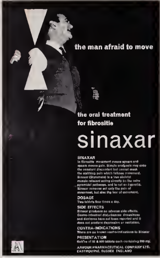
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Journal

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EDITED BY

THE STAFF OF THE ROYAL NAVAL MEDICAL SCHOOL
ALVERSTOKE HANTS

HER MAJESTY QUEEN ELIZABETH II

Editorial

REFERENCE was made in the editorial of the spring issue this year to the Royal Naval Medical School's Fiftieth Anniversary. By a happy coincidence the Royal Society of Medicine also celebrated the Fiftieth Anniversary of their house in Wimpole Street and to mark the occasion organized a soirée on the 21st of May at which Her Majesty the Queen graciously consented to be present. The three Services were invited to produce exhibits of general medical interest in the Wellcome Library and an opportunity was taken by the School to present, with pictures and models, fifty years of naval medicine. It is with great pleasure therefore that we are able to open this issue with a photograph of Her Majesty taken as she spent a little while at the naval stand. It is difficult to find words to describe such an outstanding occasion and to express the deep feelings of appreciation of those who had the good fortune to be present.

* * *

Quite important scientific achievements frequently escape the attention of the National Press and certainly worthy of scoop treatment was the recent transmission via TELSTAR of *coloured* television from this country to America. This was achieved by the active co-operation of the Royal Navy and its Medical Service. It is therefore, with very great pride that the narrative of events on this undoubtedly historic occasion is exclusively reproduced in this JOURNAL. The story speaks for itself and is another instance of the active part the Royal Naval Medical Service is playing in international medicine.

Articles

THE FIRST LIVE TRANSATLANTIC COLOUR TELEVISION TRANSMISSION

By Surgeon Commander T. A. TURNBULL, R.N. (Retired)

On Wednesday, 12th September 1962, the Royal Navy and the Royal Naval Air Station Culdrose participated in a unique scientific venture. At 15.45 B.S.T. on that day the first live transatlantic colour television programme was beamed from the Royal Naval Air Station Culdrose to Andover, Maine via Goonhilly, Cornwall. Black and white television had successfully been transmitted through TELSTAR across the Atlantic on several occasions but for technical reasons it was questionable whether TELSTAR could transmit live colour television pictures, although still colour pictures had been transmitted on one occasion from east to west with reasonable success.

As soon as TELSTAR was operational, Smith, Kline and French Laboratories of Philadelphia, who pioneered live medical colour television in the States, considered the possibilities of using TELSTAR for a live transatlantic colour television demonstration, but for various reasons this had to be delayed. However, early in September 1962 the project was reconsidered as the 12th International Congress of Dermatology, at which some 3 000 doctors from fifty countries would be attending, was being held in Washington. This was clearly an occasion where a medical colour television demonstration between Great Britain and the United States could make a valuable contribution to medical and scientific knowledge. To quote Arnold Toynbee, the British historian, "To get to know each other on a world wide scale is the human race's most urgent need today", and this is where TELSTAR can help us.

On Sunday, 2nd September, Dr. Donald M. Pillsbury, President of the Dermatological Congress, left Washington to discuss the project with British Dermatologists and Smith, Kline and French Laboratories Ltd., who have operated a mobile medical colour television unit in England since 1957. A meeting was held at Welwyn Garden City, p.m. on Monday, 3rd September, at which it was decided the colour television unit could cover this special requirement, although time was short. There were only eight full days in which to bring together a panel of eminent British dermatologists, suitable patients and the technical facilities of the B.B.C. and the G.P.O., without whose willing co-operation this programme could never have been undertaken. It must also be realized that all these "variables" had to be brought together within a suitable microwave radius of Goonhilly in Cornwall, some 280 miles from London.

The decision to go ahead with this venture meant that the Marconi built 405 line (English system) unit had immediately to be converted to the American 525 line system. Of necessity, this had to be done in 48 hours as the unit had to leave Hertfordshire on Friday, 7th September, in order to be in West Cornwall by Sunday, 9th September, as it takes approximately a day and a half to rig the portable television studio and to establish "outside broadcast" facilities. This was undertaken by the

[illegible] Marconi tech [illegible] [illegible] Mr Geo [illegible] [illegible] England [illegible] September.

It was originally [illegible] that the programme would be relayed by [illegible] link from Plymouth to Goonhilly but it was subsequently found that the link could not handle 525 line colour signals. The B.B.C. suggested that the Royal Naval Air Station Culdrose might be a suitable site as facilities had been offered to them there previously for black and white TELSTAR transmissions. The Royal Navy was approached and permission to broadcast from the Royal Naval Air Station Culdrose was granted. When Culdrose was made available the Medical Director General of the Navy was informed and Flag Officer Flying Training informed the Chief of Naval Information of this unusual broadcast.

Owing to the shortage of time at his disposal Dr Pillsbury had contacted several British dermatologists by transatlantic phone before leaving Washington. Four consultant dermatologists were present at a small dinner party given by Dr Goldsmith at the Royal Society of Medicine on Tuesday 4th September at which it was agreed that "Advances in the knowledge of psoriasis" would be the most suitable subject for a transatlantic colour television programme to the Congress of Dermatologists in the time available. At this meeting the consultants present agreed to the suggestion that they should constitute the British panel and an invitation was sent to Surgeon Commander R. Scott of the Royal Navy to be a member of the panel. A similar invitation was also sent to Dr Mark Hewitt the Consulting Dermatologist to the West Cornwall clinical area. At the end of this dinner party the panel arranged to meet again in London on Sunday 9th September to finalize the programme. Dr Hewitt, though unable to attend the meeting very kindly arranged for seven patients to be demonstrated and forwarded their case histories to London.

On Wednesday 5th September it was possible to proceed with hotel and rail bookings for the panel technical and production staffs. This involved bookings for some 30 people a somewhat formidable undertaking when it is remembered that this was at the height of the holiday season. Hotels were arranged as far apart as Penzance and Truro and night sleepers were booked for the panel for Tuesday night down and Wednesday night back. The Royal Naval Air Station Culdrose very kindly accommodated the technical and production staff. Here it may be of interest to note that four out of the five colour television unit executives are retired regular naval officers. On Friday evening 7th September the mobile unit left London for Cornwall the die was cast.

The communication satellite TELSTAR is a sphere weighing 170 lbs measuring 34 inches in diameter. It was developed by the American Telephone and Telegraph Company for experiments in long distance microwave transmissions. TELSTAR circles the earth about once every 2½ hours in an elliptical orbit at a speed of 18 000 miles an hour with altitude ranges from a low (perigree) of about 600 miles to a high (apogee) of 3 500 miles. In effect the use of TELSTAR is limited to approximately 15 minutes at any one time in a given area that is the time it is above a pre determined horizon on its orbital circulation. The mobile colour television unit at Culdrose gave the colour picture to the G P O who had a transmitting van outside the hangar. The G P O beamed the signal to Goonhilly two miles away by microwave link. Goonhilly then

[illegible] transmitted there. [illegible] picked up by the American [illegible] Company at Andover, Maine [illegible] Washington some 800 miles away. The last link was formed from the [illegible] the Shoreham Hotel by microwave link where the Congress was being held. [illegible] 15 minutes of viewing time would be available from Great Britain for the [illegible] this period was incorporated in a transatlantic telephone link. Fifteen minutes [illegible] introduction and discussion, 15 minutes of colour television viewing via TELSTAR and then a further 30 minutes discussion.

The British panel met for the second time on Sunday, 9th September, and [illegible] lated the various parts of the programme, the details of which were then [illegible] phoned back to Dr. Pillsbury who had returned to Washington. The programme was mapped out on the back of an envelope in the best traditions of the Service [illegible] the Staff College! On Tuesday night the panel left London by night sleeper; they were met at Penzance, breakfasted and then driven to Culdrose where they saw the patients for the first time and took part in the one and only rehearsal before the actual transmission. The seven patients from Cornwall had been collected from all over the county by Mr Gaunt, Records Officer of the Royal Cornwall Infirmary, Truro, to whom the colour television unit are greatly indebted. A further two patients had been brought down from London, one of whom was an Army patient from the Queen Alexandra's Hospital, Millbank. The Senior Medical Officer of Culdrose organized day accommodation and his staff assisted the Cornwall Ambulance Service in preparing the patients for demonstration.

After lunch in the wardroom of Culdrose the panel assembled in the studio which had been rigged in one of the hangars at the Air Station. Just previous to their assembly contact had been made by transatlantic cable with the 12th Dermatological Congress in Washington and at 3.30 p.m. B.S.T. (10.30 a.m. in Washington) the introduction to the TELSTAR programme was made by the Chairman in Washington, Dr. D. M. Pillsbury, and for approximately 15 minutes introductions were made followed by a short discussion of psoriasis. Patients were undressed, sitting in the ambulance by the side of the studio and as soon as the G.P.O. at Goonhilly gave us the TELSTAR contact, the first patient was being televised. There was some four minutes delay in transmitting due to technical difficulties in the United States. They were able to receive black and white but not colour. However, this was rapidly corrected and for about nine minutes good colour was received in Washington. The colour was satisfactory and Surgeon Commander Scott was able to demonstrate seven cases before TELSTAR passed over the horizon. During the demonstration both panels were able to discuss specific points with live colour television pictures of the patients on the 9 feet × 12 feet (108 square feet) screen in Washington and a 21 inch colour monitor at Culdrose. It is understood that this experiment was received by the Congress with acclamation. The technical opinion was that although the colour was good it was not as good as a closed circuit colour television picture, but when one considers the difficulties and the shortage of time at the disposal of both colour television units, it is fair to say that this was a most successful pioneering experiment.

When TELSTAR was lost, both panels continued the discussion of psoriasis and

elaborated on the various treatments now available. The colour television unit is in great debt to the Royal Navy, the General Post Office and the British Broadcasting Corporation for their great co-operation in this venture. Without their help it would not have been possible.

PANEL MEMBERS

United Kingdom Panel

Chairman: DOCTOR G. B. DOWLING, M.D. (LONDON), M.D. (HON.) UTRECHT, F.R.C.P. (LONDON)
Consulting Physician to the Department of Dermatology, St. Thomas's Hospital, London. Consultant in Dermatology to the Royal Air Force.
Panel Members: DOCTOR W. N. GOLDSMITH, M.D., F.R.C.P.
Consulting Dermatologist, University College Hospital, London.
DOCTOR R. M. B. MACKENNA, M.A., M.D., B.Ch. (CAMB.), F.R.C.P. (LONDON)
Physician in Charge, Skin Department, St. Bartholomew's Hospital, London. Consultant in Dermatology to the British Army. Corresponding Member, American Dermatological Society.
DOCTOR H. R. VICKERS, M.A. (OXON.), M.D., F.R.C.P.
Lecturer in Diseases of the Skin, University of Oxford. Consultant Dermatologist, Radcliffe Infirmary.
SURGEON COMMANDER R. W. B. SCUTT, ROYAL NAVY, M.B., B.S. (LONDON), M.R.C.S. (EDIN.)
Senior Specialist in Dermatology.

United States Panel

Chairman: DONALD M. PILLSBURY, M.D.
President 12th International Congress of Dermatology. Professor of Dermatology and Syphilology, University of Pennsylvania School of Medicine.
Panel Members: CLARENCE S. LIVINGOOD, M.D.
Director, Department of Dermatology, Henry Ford Hospital, Detroit.
REES B. REES, M.D.
Associate Clinical Professor and Chairman, Department of Dermatology, University of California, San Francisco.

DROWNING

(A review of the subject, with special reference to the mouth-to-mouth method of artificial respiration)

By Surgeon Lieutenant-Commander G. A. R. GIRI, R.N.

Much recent research, the reintroduction of old methods of artificial respiration and the fact that this subject, which should be close to the heart of naval medical officers in particular, has not been treated in this Journal for a very long time prompt the following study.

Since the late eighteenth century the problem presented by drowning has prompted only sporadic interest in high places, a strange fact because a study of the statistics reveals a problem in terms of sudden death that is impressive.

The deaths due to drowning in this country have remained fairly constant at about a thousand per annum over the past twenty years and in the fine summer of 1959 double that number were recorded. Efforts to improve this situation do not appear to have been very successful and drowning joins road accidents in an upward trend. There may be a significant increase in swimmers and aquaphiles, but this has certainly not been so startling as the increase in the number of propelled vehicles on the road.

A study of the figures relating to the comparative importance of drowning as a form of accidental death and a break down of the drowning figures where this is possible reveal the following points.

Figures from the United States (Met. Ins. Co. Stat. Bul. 1953) show that if road accidents are excluded the most important cause of accidental death in children between the ages of one and five, is drowning. The peak of these accidents is surprisingly at one year. These deaths occur in the most unlikely places, usually far removed from open water, thus baths, fish ponds, puddles and similar hazards take their toll.

When considering the mortality rate throughout the life-span, the peak is reached between the ages of twenty and twenty five and this can be attributed to the great athletic activity of this age group, and also to the fact that at this time they will take risks and frequently themselves succumb when trying to save others in all age groups. In the break-down of total accidental drownings in England and Wales it can be seen clearly that the male rate is consistently higher than the female rate. Some of the reasons are given above, but there are two peaks at the ages of five and fifty which need further thought: the former is probably due to the greater adventurousness in small boys (female figures of this age are much smaller) and evidence for this can be found in the higher general accident rate in small boys. The peak at the age of fifty is probably due to male swimmers undertaking tasks beyond their strength. Observation indicates that males of this age are more frequent swimmers than females. If accidental drownings are compared with deaths by falling (which, in England and Wales, still

accounts [illegible] accidental deaths) it still [illegible] size of the pro[illegible] drowning at the figure [illegible] of the [illegible]

Prevention

The prevention of drowning, excluding those accidents attributable to "Acts of God", should present an easy problem. Much of the mortality could be avoided if children bathed under supervision, if those who play on water had means of remaining afloat, if known risks were avoided, and if resuscitation were a universally known and practised art. Unfortunately often, as we shall see, the rescuer is bound to be too late.

Clinical problems

Drowning is an accident which either kills or leaves the patient in good health. Apart from treatment for shock, and other symptoms common to all accidents, the clinician is not called upon to deal with any stages of recovery. Crossfill (1956) recalls a fatal case of pulmonary abscess following the immersion in contaminated Thames water and though this raises the question of antibiotics as a standard treatment, it must be a sequel which is extremely rare.

General considerations

Drowning accidents occur in many places in and around the home and in larger and smaller stretches of water following a fairly consistent pattern. In the United States, out of an average figure of 7 000 deaths per year from drowning (Stat. Bul. Met. Life Ins. 1955-56) 1 200 are water transportation accidents, four out of five of which occur in various types of small boat. Frequently boats are hired without thinking of the dangers. Small boat sailing and underwater sports are fields in which great increase in activity is now evident, and here is a field where drowning accidents can be expected to become more frequent.

There are also basic psychological factors which must be taken into account. The man who drowns, though able normally to remain afloat, may panic through fear. Dietrich (1953) points out that adulation of water in the young may lead to fatal experiments later in life.

We shall consider what steps can be taken to prevent drowning accidents later on. So far an attempt has been made to show that a considerable problem exists and as it may well increase, it merits further attention.

Historical Review

From the very earliest times in recorded history there have appeared periodically either pictures or accounts of methods to attempt to resuscitate the apparently drowned. It is clear that the ancients, be they Chinese or Egyptians, considered the important part of the process to be the evacuation of the water that had supposedly got into their lungs and to this end the Egyptians hung their patients by the heels practising a two phase method, alternately pushing and pulling, whereas the Chinese laid their patients over a beast of burden which, if it worked, achieved a form of one-phase jolting respiration. Since those times artificial respiration, by whatever method, has always been divisible

roughly into one phase (this means the assistance of either expiration or inspiration) and two phase methods (which means the assistance of both inspiration and expiration) Apart from the mechanical methods used and Elisha's famous success obviously many forms of potion witchcraft and stimulation were practised of these most forms relied on the known fact that sudden painful stimuli can make one gasp for breath Coals were placed on the abdomen in one such method Various ways of stimulating the central nervous system via the anus were used Amongst primitive tribes the blowing of tobacco smoke into the rectum by various apparatus was a method which was handed down through the ages and was abandoned in the Royal Navy only in the year 1812. Though condemned this method had foundations in science most midwives know but will not admit that the use of a finger in the anal orifice of the new born child is an extremely efficient method of initiating respiration Various methods of artifical respiration used through the ages are shown in the accompanying illustrations

Fig 1 Head down position combined with pressure on the stomach

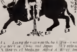


Fig 2 Laying the victim on the back of a cow was practised in China and Japan (Castiglioni A History of Medicine Alfred A Knopf Inc 1947)

Fig 3 Barbaric method Placing live coals or burning animal excreta on the victim's abdomen

Fig 4 Fumigation Originated by North American Indians Tobacco smoke was collected in an animal bladder then blown into the victim's rectum

Organized preventive measures do not appear to have been instituted before the eighteenth century, and these accompanied the philosophical activity that was stirred up by the big physiological advances made at that time One of the first references is

in the second decade when some observations were made regarding the resuscitation stations under the bridges of Paris At this time though breathing into the mouth was recognized as a restorative measure the physiology was barely understood and the methods relied on were concerned with the principles of water evacuation and stimulation These stimuli involved almost every part of the anatomy and elaborate tables were drawn up showing their uses (Histoire de l'Academie Royale des Sciences 1719)

Physiological advance during the century was rapid In 1767 the Amsterdam Society for the Recovery of Drowned Persons was advocating the use of bellows (Fig 5) In 1774 the Royal Humane Society was founded and appears to have stimulated a flood of activity, the papers by Goodwyn and Kite in 1788 on asphyxia and drowning were to win medals of the Society but no fewer than six other papers on the subject were read

Suffice it to sum up the knowledge and practice on the subject of drowning in the late eighteenth century The emphasis shifted away from emptying water from the lungs many experiments were conducted on animals which cast doubt on the fact that water ever entered the lungs John Hunter in 1774 (Philo Trans Vol XVI Part 2 Quarto London) in proposals for the recovery of drowned persons concluded that "Drowning is a stopping of life without damage to a vital part" and that breathing would restore the heart's motion Fothergill and Henley at about the same time accepted this but were great protagonists of the use of electricity to restart the heart a practice which found its advocates throughout the second half of the century In 1788 Goodwyn and Kite read their papers to the Humane Society They disagreed for practical purposes only on whether water entered the lungs or not Goodwyn following experiments in which he drowned cats in quicksilver and ink said that it did Thus he described a brass cylinder (functioning like the Oxford inflator of today) which would either pump out water or pump in air and advocated the warming of the body Kite was only interested in pumping in air and to this end quotes the Humane Society instructions for the recovery of the apparently drowned "Direct an assistant to blow into the mouth through a coarse cloth or use bellows" He goes on, however with words that have their echo today "The blowing into the mouth may upon an emergency answer for a few times but the difficulty of getting people to continue it will be easily conceived on account of the operation being so extremely disagreeable and troublesome"

A large variety of ingenious pipes are described for coupling the lungs via the nose and mouth with the bellows

The turn of the nineteenth century saw methods of stimulation losing ground because they did not produce results many methods of introducing air into the lungs were advocated Electrical stimulation of the heart was practised As far as physiology was concerned it was only the nature of the exchange that occurred in the lungs that was still subject to philosophical speculation

The nineteenth century shows a steady swing away from mechanical respirators and mouth to-mouth respiration to manual methods of stimulating breathing by moving the thoracic cage which in the first half of the century were unknown Curry in his book on apparent death (Edinburgh, 1815) further supported the doctrine that water did not enter the lungs after considerable post-mortem research He realized

Fig 5 Bellows method [illegible]

Fig 6 The [illegible] method [illegible] Release [illegible] expiration

Fig 7 The use of a barrel

[illegible] Lifting [illegible] expiration

Figs 9 and 9a Emerson Ivy method

Fig. 10 The Laborde method Rhythmic traction of the tongue The mouth was kept open by inserting some object such as a cane

Fig. 11 Eve's rocking stretcher method

Fig. 12 and 12a The Nielsen method of artificial respiration Expiration is obtained through pressure on the shoulder blades inspiration through the arm lift

the dangers of pumping air into the stomach and advocated a tube with an inflatable cuff to be inserted into the œsophagus and a box-wood or silver tube to be inserted into the trachea these were to be connected to bellows or blown through via the operator's mouth

Kay (Asphyxia 1834) introduces Leroy's attachment to bellows for measuring the amount of air blown in and a scale to be used for assessing the quantity at various ages, in an adult 100 cubic inches (1 638 c c) were thought to be the right amount Leroy's bandage (similar to a many-tailed abdominal bandage) which was operated as in the Dalrymple method (Fig 6) was advised as a way of restoring respiration from without

In writings at the beginning of the century however [illegible] expressed about the danger of rupture of the lungs which is shown to have been [illegible] by the use of bellows Kay recommends bellows to experts only and this may be the beginning of the decline in their use

The Cyclopaedia of Medicine (Forbes Tweedy and Connelly 1833) sums up Mouth to-mouth respiration through a tube the application of warmth are the rescuers principle aids Various other aids may be used if these are to hand but bleeding and the stimulants of one hundred years ago are deprecated.

It is difficult to see why the inflatory principle loses ground from now onwards Since Elisha resuscitated a child by mouth to mouth respiration and some form of pressure on the chest the method and principles have been exploited yet the next hundred years are devoted entirely to various forms of manual and mechanical external aids Fear of lung rupture may have been a potent reason for this but one suspects that Victorian prudery was also a factor In 1858 Sylvester s method was published one of the first of the manual methods and one which with Thomson s modification was still in use in Germany in 1932

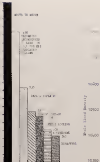
Below are briefly enumerated the methods of importance evolved since then in order to give a picture of the progress made

(a)	**Marshall Hall**	1865	By rolling to and fro
(b)	**Howard**	1869	Single phase method patient lying on his back Pressure applied to the chest.
(c)	**Laborde**	1892	Patient lying on his back pulling at the tongue (this method surprisingly found many adherents and may of course have had some basis in the type of frog breathing practised by polio cases with total respiratory paralysis)
(d)	**Schaefer**	1903	A single-phase method with the patient in the prone position pressure applied above the loins (this method achieved almost universal popularity but as with all methods modifications and malpractice were introduced to the detriment of efficiency)
(e)	**Eve**	1932	A rocking method on a board (relying on the displacement of the abdominal contents)
(f)	**Emerson-Ivy**	1935	A two-phase method involving hip lifting with the patient in the prone position (extremely tiring)

In 1932 Lieutenant Colonel Holger Nielsen evolved and published his two-phase one man method with the patient in the prone position which has been adopted as superior to all other methods up until the last few years Very recently Elisha s method has come back into prominence owing to proved evidence of its superiority over other types of artificial respiration and this will be discussed in detail

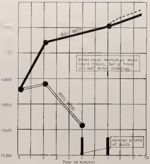
A table is appended which gives a clear picture of the ventilatory inefficiency of many of the methods enumerated above In this table methods were compared under laboratory conditions the anesthetized subjects in all cases except the mouth to mouth subjects had artificial airways thus although the Holger Nielsen method would appear to produce satisfactory ventilation it is doubtful whether this would be

TABLE I



Comm 61 47 86 J.A.M.A 17 Mar 56 Safar Res. Asphyxia 1854

TABLE II



Diagrammatic representation of figures from Med Dir Spec Rep No 5 U.S. Army 56

After J. ELAM et al J.A.M.A. 66.

[illegible] conditions The tidal volume is the [illegible] air which passes through the mouth in one movement of exp[illegible] there is a further quantity of air which occupies the space betw[illegible] lungs which is not concerned with the process of respiration [illegible] called the dead space

The Royal Life Saving Society (founded 1891) The Society for the Prevention of Accidents, The Society of Red Cross and St John and many others consolidated practice as regards the resuscitation of the drowned in the first fifty years of this century and little fresh work on the subject was fostered or had any effect on the position until quite recently

PHYSIOLOGICAL FACTORS

Arteria Animam accipit e pulmonibus (Cicero)

It is clear from the foregoing that artificial respiration has been and must, in the absence of sweeping preventive measures, remain the most effective method of preventing the death of the apparently drowned Recently much physiological research has been done on this problem and there now follow a few of the significant points that emerge and which are necessary to have a true picture of the problem

Firstly the problem of drowning is clearly differentiated into two parts There is a basic physiological difference between drowning in fresh water and in salt water It has been shown that when fresh water enters the lungs (of dogs) enormous quantities of water pass with extreme rapidity through the alveolar membranes which provide a very great surface area due to the difference in osmotic pressure between the blood and the liquid that has entered the lungs This rapid hæmodilution (this is illustrated in Table 2) reduces the blood density by ½ in 5 minutes This fact and the lysis of erythrocytes that results disturbs the K-Na balance causes a drop in sodium ion concentration and it is this that probably leads to the ventricular fibrillation which is the subterminal event, before the respiratory centre has been affected by any degree of anoxia Death in fresh water drowning if water has entered the lungs can occur within a minute of submersion (Med Div Spec Rep No 56 Swann *et al* 49) Some immediate deaths may be due to vagal inhibition some confirmation of this is the fact (Halmagyi and Colebatch 1961) that vagotomized sheep do not suffer sudden death

What happens if fresh water enters the lungs is quite clear It is curious therefore that those saved from death by drowning in this medium exhibit no resultant syndrome one might have expected hæmaturia or various paralyses and jaundice because of the hæmolysis

In salt water although the difference in osmotic pressures are not so extreme the reverse occurs fluid now passes from the blood through the alveolar walls into the lung spaces

The post-mortem findings have recently been clarified (op cit) until recently the only finding was the frequent absence of fluid in the lungs and the presence of blood-stained tenacious protein froth It has now been shown that even very small quantities of salt water produce a great increase in elastic resistance of the lung rupture of some alveoli was produced and there was a shunt of blood into unoxygenated areas of the lung The pressures required to open up collapsed alveoli was so

great that there was no danger of rupturing normal vessels. These factors may not apply to man but they fit in with the findings at post mortem (Donald 1955).

The passage of fluid from the circulation is slower though, as can be seen from Table 2 the hemoconcentration rises considerably, there are probably contributory causes for this (op cit). Ventricular fibrillation however does not intervene and respiration due to cerebral anoxia, is likely to stop before the heart. This materially increases the chances of survival provided that irreversible cerebral damage has not already occurred. Even so, in dogs death was only delayed by an average of 2 minutes longer than in the case of fresh water (Swann *et al* 1951). The K-Na ratio is not disturbed in salt-water drowning and it follows that estuary drowning in waters osmotically comparable with blood would not prolong life the condition would here be one of fulminating anoxia due to loss of respiratory exchange surface and catabolic build up.

For dogs the initial period of struggling after submersion was often followed by a gasp which allowed the entry of water into the lungs but this was often delayed for a significant period by a spasm of the glottis. In man there is evidence that in those saved from accidental drowning such a spasm, and possibly other protective mechanisms sometimes of a psychological nature are evoked. It has frequently been observed and those who have escaped from near drowning have borne witness to the fact that at the last moment, water is often swallowed rather than inhaled and even that this action produces a temporary relief.

What then is the criterion by which we can judge the time of death when there has been no inhalation of any significant quantities of water? (and therefore no electrolytic disturbance or lung reactions)

Swann *et al* (1951) tried the effects of varying types of anoxia on dogs. In fulminating anoxia caused by the admission of pure nitrogen it was found that provided the systolic blood pressure was 105 mm or more oxygen always succeeded in restoring circulation but failed in all cases where it fell to a point below 75 mm. The average time between these two points was 15 seconds. Breathing in this type of anoxia always fails before circulation. The cerebrum failed at 6¼ minutes after anoxia, and the dogs never recovered but at 5¾ minutes recovery took place. In acute anoxia with the presence of small amounts of oxygen in the nitrogen the same occurred as above, but there were occasions when circulatory failure occurred before respiratory failure and the onset was slightly prolonged. In obstructive asphyxia breathing failed first 3 minutes anoxia was an overwhelming insult but not until 2 minutes after circulatory failure. As little as 1 per cent oxygen was found to prolong the life of the asphyxiated animal by several minutes, though in types of anoxia where the systolic pressure fell to 100 mm circulatory collapse was imminent and had occurred when it reached 50 mm the time interval between these two points was 20 seconds. Oxygen would only revive the dogs with blood pressures above 100 mm. It appears that in animals at least a degree of anoxia causing the blood pressure to fall below a certain point is an irreversible insult which occurs in about 5 minutes when no other of the previously described adverse factors (of drownings) are present (op cit).

Other physiological factors affecting the condition are few. Convulsions in the unconscious patient will tend to use up oxygen reserves. Drowning in cold waters,

with its accompanying peripheral [illegible] by prolonging cerebral and myocardial oxygenation. In hot waters the extra burden of the added peripheral circulation may effect the reverse. This should be remembered by rescuers as while resuscitation is proceeding, warming of the extremeties may merely open up a circulatory load on the heart which is more than can be tolerated at the time. Actual consideration of the amount of oxygen required to prolong life and the mechanical factors involved will be considered when methods of artificial respiration are dealt with.

Experiments are being done on larger mammals which show very much the same physiological changes enumerated, and there seems no reason to doubt that human beings will react similarly.

In some cases where post-mortem examinations have been made in humans (and they have to be made very soon after drowning) electrolyte balances were such as were likely to produce ventricular fibrillation. But post-mortem findings, probably due to the time-after death factor, tend to produce equivocal and bizarre results.

Looking at these facts it is obvious that experimental material and evidence is almost unobtainable in man. But it seems likely that one can assume that man falls into the same pattern as is found in animals. Swann *et al.* (1951) considered that 20 minutes must be the absolute maximum of survival in man with simple anoxia. This figure does not take into account any osmotic effects or adverse conditions and as cerebral damage is never seen in those who have survived (Crossfill, 1959) it seems unlikely that man can survive this longer than 10 minutes. From another point of view it is unlikely that man can be resuscitated after the heart has stopped beating for 4 minutes, and even this means that the anoxia must not have been such as to cause irreversible damage to the brain, and there must not have been osmotic changes. Kay (1834) wrote: "Seldom or never can a person immersed 5 minutes in water be restored to life. But syncope may continue for a much longer period without any sign of life being manifest and complete restoration may then speedily ensue."

This damage to the brain may be averted by the presence in the inspired air of as little as 1 per cent oxygen; this however presupposes that water entering the lungs has not caused any loss of respiratory exchange surface or other reactions as described. In fact if damage has been done to the myocardium by low oxygen tension, no recovery can be expected. If irreversible damage to the brain has been done there is no hope of recovery, even if the heart is still beating. Theoretically it is possible that the post-drowning syndrome exhibiting signs of cerebral damage (e.g. dementia paralytica) should exist in certain cases. However, no such syndrome is described in the human, though it has been seen in animals, and therefore it seems that in man irreversible anoxic damage to the respiratory centre precedes or coincides with permanent cerebral damage.

Implications of Experimental Factors

A fresh attitude must be adopted to methods available for saving victims from possible drowning, after the head has been raised from the water. There is a severe limitation on the amount of time available in which events leading to death can be reversed, and various physiological and physical factors affect what can be done.

In methods used recently the idea was that when the case had been brought to the shore some mechanical method of moving the thoracic cage should be used, which

by simulating [illegible] movements of breathing (in the [illegible] of [illegible] cerebral anoxic depression) would ventilate the lungs to give [illegible] to the blood and [illegible] re-start its spontaneous activity in the respiratory centre. By [illegible] it was claimed that even if the heart had stopped mechanical circulation of a certain quantity of blood could be sufficient to re-start activity in the respiratory centre (J. de Phys. Paris 1958).

As previously discussed and as shown in Figure 5 the effects of attempts of this sort on the ventilation achieved can be seen to be extremely small. These figures were obtained by using anaesthetized patients with artificial airways and measuring the total volume that could be achieved with the various methods. This is however not the whole picture. These methods, at the time of testing, were used under laboratory conditions: no water had interfered with lung function or had entered the circulation and the airways were artificially clear.

It has been shown repeatedly in many series recently that even approved methods of applying some advocated manual methods do not ensure a clear airway, and as used, therefore, cannot in many cases have contributed to the recovery of the patient. It has also been shown that in the Schaefer method it is very difficult to ensure and maintain a clear airway and that though this can be ensured in the Holger Nielsen method by bringing the chin very far forward and extending the neck to the utmost, this was not the method normally taught in countries away from that of origin (Denmark).

The mere fact that six different methods of manual artificial respiration were, until recently, taught in various countries points as always when there are many panaceas but few cures to the fact that none of these methods is the real answer or more effective than the others.

One practical consideration arising out of the last chapter is that if the experimental results are to be taken seriously, only seconds may be available to the rescuer in which some sort of ventilation *must* be initiated. It is not sufficient to wait for the patient to become unconscious and then bring the victim to the shore. For then his airway must be cleared, he must be put in the correct position for a badly remembered and probably tiring method of artificial respiration and by then much time has been lost. The procedure as recommended is to continue this method of resuscitation for two or three hours but the time elapsed before initiation usually means what amounts to an exercise on a dead person.

Therefore, where possible, this ventilation must be started as soon as the rescuer establishes contact with the victim, and this may be out at sea.

No method of manual artificial respiration is of much use in water. The difficulties are insuperable. From the foregoing it is obvious that the time factor is extremely critical and to wait for the patient to become unconscious (in order the more easily to bring him to the shore) not only clips vital time out of the minutes available for resuscitation but deprives him even further of oxygen which he at that moment desperately needs.

So we come inevitably to the positive pressure methods of ventilation which have now been proved to have complete precedence over the other methods, not least because they can be initiated in the water.

The Mouth-to-Mouth Method

The mouth-to-mouth or mouth-to-nose method of artificial respiration is the exercise of the rescuer's blowing power used as a pair of bellows in the same way as the Oxford inflator to ventilate the victim's lungs. To start with it may be asked why not use the Oxford inflator or similar apparatus which has a proved efficiency superior to manual methods? The answer is that any method relying on apparatus will too often be useless as it will rarely be to hand. The man strolling along the river bank who witnesses an accident cannot use apparatus he has not got. However, apparatus is of value in such places as lifeboats (The Royal National Lifeboat Institution is equipping its boats in this way) and beach first-aid posts.

The method is extremely simple: ensuring a clear airway by holding the head back and closing the mouth or nose, whichever is not to be used, the rescuer places his mouth over the open orifice and exhales; he then removes his mouth and the patient exhales through the natural elasticity of the thorax (Fig. 13).

The immediate objection to this procedure is that it is unaesthetic. Many human practices the world over are considered unaesthetic by people unused to them, and though this may have been excused as argument before the physiological facts were established, aesthetic consideration cannot be taken into account if it is a question of

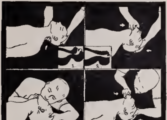


Fig. 13. M[illegible] 1 and 2 show [illegible]

saving life. [illegible] these [illegible] it has been shown that a handkerchief interposed will not seriously interfere with efficiency.

Can the method be applied by anybody? It certainly has simplicity and many experiments on anaesthetized curarized patients have been done. In one series Ruben *et al.* (1959) tried it out on 300 patients with a group of 28 laymen with complete success. Safar *et al.* (1958) in the United States found that women and boy scouts could easily ventilate people twice their weight, maintaining a tidal volume of between 1,000 and 2,000 c.c. for 30 minutes without tiring. It required only one demonstration to teach 90 per cent of these untrained laymen how to do it successfully. Elam (1960) and most of the principal workers in various countries have agreed to common procedure usable by anyone.

Was this hyperventilation going to make the operator dizzy? And what was the oxygen tension in the air from the operator's lungs, as the alveolar CO_2/O_2 ratio differs from that in the air? Van Weerden (1959) showed that, with the tension found, a tidal air of 950 c.c. was required, if a ventilation rate of 17–20 per minute was kept up. At this rate a partial pressure of CO_2 of 28–30 mm. Hg, which was comfortable, could be maintained indefinitely without tiring the operator or causing other effects, and this also provided a sufficient margin for leakages. To find the patient's reactions a case was chosen with complete respiratory paralysis and the above theoretical times applied. The insufflated and expired air was analysed as also was the blood. O_2 saturation remained at 95 per cent and both rescuer and patient felt well. There is therefore no objection to the method on the theoretical ground that expired air is not the same as fresh air, nor on the grounds that any side effects in the form of dizziness are likely to incapacitate the resuscitator; in fact the slight increase in CO_2 might have some stimulating effect on the respiratory centre. The dead space in the rescuer's bronchi helps to dilute the higher concentration of the alveolar CO_2.

It has been maintained by workers that artificial respiration of the manual type provided an essential movement in the thorax, helping to maintain circulation. Only the most inefficient methods from a ventilatory point of view produced any effect, and that only of the order of 2 cm. mercury in the arterial blood. It cannot really be supposed to have had any effect on the course of the resuscitation. Movement of the thorax can be shown to have some effect however after the heart has stopped beating (Safar, 1960) and firm pressure on the sternum between each inflation has been successful in restarting the heart action in many patients.

The problem of maintaining a clear airway arises in all methods. One is forced to the conclusion that in the past much effort must have been wasted when there was in fact no clear airway. If the head is held back there is no problem in the mouth-to-mouth method. Furthermore it is immediately obvious to the operator if he is experiencing undue resistance or inflating the victim's stomach. A two-way artificial airway has been advocated which is the obvious answer for professional life savers who can carry it in their belt and know how to use it. (A return to those advocated in the eighteenth century.)

The stomach often has a large quantity of water in it at the time of rescue. This should be disregarded as it seldom gives rise to any trouble.

In 197[illegible] Meinicke laid down conditions for methods of artificial respiration These were

(1) An artificial respiration method can only then be recommended if it is certain to produce no harmful effects when applied carefully

(2) To be recommended an artificial respiration technique must of course first of all bring about adequate ventilation to the lungs but in addition it must also have a favourable influence on blood circulation in the lungs and to promote the heart function as much as possible

These conditions still hold but to them can be added

(3) That it should be easy to learn and remember

(4) That it should not be tiring

(5) That in an emergency it should not require apparatus

(6) That it should be applicable regardless of injuries in the patient

Mouth to mouth breathing as a method quite easily fulfils these conditions It has the immense advantage that a vital breath or two may actually be administered while the victim is still in the water Also it is difficult to forget

The final objection which has been raised by many of the interested societies is "How can one teach the method?" There are obvious practical and ethical difficulties to using curarized patients as has been done in the experimental work Yet the need is for an unconscious patient

The question has been satisfactorily solved by the production of dummies that faithfully reproduce all the conditions necessary including the remote one that over enthusiasm may produce over inflation in the stomach rather than in the lungs This can easily be observed and the dummy shows up this danger It is so built that adequate head position must be maintained to secure the clear airway which is so necessary to ensure success The dummy is easy to use and many people can be taught by the relatively unskilled There are now many films and film strips etc. available

Prevention

To study drowning as a public health problem should mean an emphasis on prevention rather than cure and at first sight this may appear a rather barren field but much more can be done than is done at present. People can be informed about the places and circumstances in which accidents take place or warning notices put up, and the places can be made inaccessible by fencing. The appended plate shows some of the types of warning that have been produced by the Royal Society for the Prevention of Accidents (Fig 14)

But by far the biggest factor is likely (except in very strange circumstances) to be the ability to swim

Iremonger (1948) in his Biography of Archbishop Temple recounts how a master at Rugby asked the Archbishop to be while discussing an essay of his, "Are you not a little out of your depth here?" "Perhaps, sir" was the confident reply "but I can swim"

Unfortunately it appears that a very small proportion of the population can answer as the Archbishop did and a further proportion certainly cannot do it confi

Fig 14

dently. And yet these people go boating, go to the seaside, run risks on canal banks and frequently expose themselves to a danger they well know they would not be able to deal with without help, but are nevertheless blissfully thoughtless about this. Frequently they will not don a life-jacket to prevent a serious situation arising.

Accurate figures of the proficiency of the general public in the simple art of swimming are not available. We can only get an idea (a) from specialized figures, i.e. service personnel, or (b) by assessing the number of school children who actually learn to swim while at school. The figures now quoted come from the 1950 report of the Council for the Promotion of Education in Swimming. Though these figures are taken from enquiries some years ago and most of the servicemen will have left the Services and are now civilians, it is unlikely that this dilution of the population with a more than average swimming-taught number would in any way affect the general figure.

Non-swimmers in three naval establishments with a 15-year old entry averaged about 60 per cent of the total numbers on joining. In universities and industry there were about 50 per cent non-swimmers (all age groups) and Metropolitan Police entries (with an average age of 25 years) had 20 per cent non-swimmers.

These figures, though not in any way representative, indicate that about 50 per cent of the population are almost certainly non-swimmers. From experience of those called swimmers in the Royal Navy it would probably be unlikely that a further 20 per cent would give a useful account of themselves in difficult situations. And this is almost certainly true of a further section of the whole population who are often not fit when they expose themselves to risk.

Investigations were also made into a number of swimming baths in urban districts and boroughs of various sizes to show how many swimming pools were available in 1950 and what use was made of them by schools in summer and in winter. At very best 75 per cent of schools made use of baths in the summer and at best 20 per cent in winter (where baths were available). It is clear that problems such as transport in urban districts may interfere, but even so it appears that at least 50 per cent of school children are never taught to swim officially. This figure corresponds with that total given previously, although these are males only, and the female figure may bring these down even further as will certainly figures from rural districts. We thus see that there is a lot to be desired on the teaching side. The first-aid societies and the Royal Life-saving Society do a lot to teach their members methods of artificial respiration, but though in the latter case swimming is a necessity for the methods taught, it would seem from a study of the literature that the Red Cross and St John and many smaller bodies and institutions teach artificial respiration without emphasis on the requirement that the operator knows how to swim.

It will be clear from the foregoing that further accidents will occur if unfit or poor swimmers make attempts to save life and merely get themselves into difficulties as well, and this in fact produces many more accidents.

> An unpractised swimmer plunging still
>
> With too much labour drowns for want of skill
>
> Shakespeare, *The Rape of Lucrece*

The impression [illegible] gained [illegible] the activities of the Central Council of Physical Recreation that swimming is an incidental accomplishment taught at their centres but not dealt with as a separate subject and there is not enough emphasis on its importance They do however have a well planned handout on safety precautions which is issued to all organizers recommending the constant use of life-jackets in situations requiring them and also insisting on a signed undertaking from all participants in activities in or on water of the ability to swim 50 yards There is not however any obligation to prove this ability and it may well be especially in the case of sailing that fish slip through the net

Masters of merchant ships still have no obligation to ensure that members of their crew know methods of artificial respiration and may not be in practice or up to date themselves

It is clear that a lot more can be done in the preventive field

Summary and Conclusions

I have thus shown with a few historical details the stage reached in the evolution of methods of artificial respiration and figures have been used which purport to show the absolute superiority of mouth to mouth breathing. It has been shown that in the prevention of drowning accidents many factors may be brought to bear and that there is a need for further use of these and that further efforts can be made in the form of propaganda

The time interval between life and death in drowning is probably much shorter than recently supposed If the heart has stopped beating in salt water drowning for 4 minutes recovery is impossible In fresh-water drowning ventricular fibrillation heralds death and the time interval is yet shorter To explain this one must postulate that those saved from drowning do not in fact get appreciable amounts of water into their lungs and when *in extremis* swallow water instead if this is the case then the condition is one of simple anoxia, which must be dealt with as soon as possible Frequently perhaps the position of the head and body in the water after unconsciousness may prevent water entering the lungs, and thus prevent this fatal event for a time The criteria affecting revival in these circumstances have been described The fact that damage to the brain is unknown in those who survive bears out the supposition that only very rarely does anyone recover from " true " drowning

In order to have any chance of saving someone in this predicament, the rescuer who is generally a random observer, must know how to swim and should know a method of artificial respiration It is unlikely that half the population of England can swim and this is attributed in the main to lack of teaching and facilities during the school years This could be remedied and would not require the building of new baths as it seems that facilities are not fully exploited There must be more propaganda and official encouragement

Very few " random observers " indeed know *any* method of artificial respiration, and if they have any ideas on the subject the interval of time required to set a partially remembered and badly executed method into operation would surely be longer than the patient's tenuous and fleeting hold on life

Practically and theoretically there are no objections to the mouth-to-mouth

method of artificial respiration [illegible] undeniable. It is extremely simple to teach and [illegible] teaching more efficient than it was in the [illegible] faithfully reproduces the state of unconsciousness [illegible] and this the conscious human cannot.

It is clear that this method must be adopted universally without delay and that aesthetic grounds are no tenable argument for procrastination.

The "random observer" will then approach the ideal in being fit and able to swim without endangering his own life and equipped to administer artificial respiration by a method which will have a chance of saving life.

Acknowledgments

I should like to thank the Royal Humane Society, the Royal Life-saving Society, the Central Council for Physical Recreation, the Royal Society for the Prevention of Accidents, and the Royal National Lifeboat Institution for the kind help their secretaries accorded me.

I should especially like to thank Surgeon Commander J. W. L. Crosfill, R.N. (Retired) for making his knowledge and help so freely available.

I am indebted to Geoffrey Challen, Esq., for his excellent drawings, many of which were inspired by photographs in the book by P. V. Karpovich, *Adventures in Artificial Respiration*.

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AGEING IN THE ROYAL NAVY

By Surgeon Lieutenant-Commander W B WRIGHT, R N (Retired)

PART I—CHAPTER I

Introduction

" It is an ancient mariner " (Samuel Taylor Coleridge)

THERE is something about the appearance of ratings of the Royal Navy which makes them tend to look older than their years

It is not at all unusual to come across a chief petty officer who looks well into middle age and turns out to be less than 40 which is the usual age of retirement Veterans of the Service due for retirement are looked upon as old men and are for example excused participation in vigorous sports yet a civilian just under 40 would as a rule be horrified to be classified in this way as he would be dismayed at retirement at this age

During my 10 years of naval service I have become more and more convinced that this difference in apparent ageing is a genuine one I am not alone in this conviction Most of my colleagues agree with me and I have often heard this opinion volunteered in casual conversation Undoubtedly there is a widespread impression in the Service that ratings appear to age prematurely

Nor would this impression appear to be a recent one Gilbert Blane (1799) observed " In consequence of what they undergo seamen are generally short lived and have had their constitutions worn out 10 years before the rest of the laborious part of mankind A seaman at the age of 45 if shown to a person not accustomed to being among them would be taken by his looks to be 55 or even on the borders of 60 "

About the same time Turnbull (1806) said " . . . yet a sea life in general is one of violent exertion in that the common duties of the ship exposes the men to much fatigue from the uncertainty of the weather and other instances These duties also require for the most part sudden and violent exertion which are more severe on the constitution than continued moderate ones Hence seamen are in general short lived and their countenance and appearance bear the marks of age before they really attain it This is most remarkable when a seaman is passed the age of 40 at which time of life anyone judging from his appearance will consider him 10 years older than he really is."

Admittedly the seamen referred to were an extremely ill nourished lot At the end of the eighteenth century scurvy was rife in the Navy Between 1744 and 1800 apart from scurvy the most serious occupational disease of seamen was hernia[1] (Coulter 1960) This surprising fact illustrates how undernourished they all were The average number invalided with hernia each year was 3 714 representing an incidence of 1 in 7 of the whole force

Nevertheless there is food for thought in these observations and they lend support to the possibility that there might be an atom of truth in the current impression. It struck me that there were deeper implications here than might be apparent at first sight.

Supposing for a moment that there were any truth in this impression. It would follow that naval ratings as a group either (a) looked more aged or (b) were more aged for their years than members of the community as a whole.

In the former case the direct implication would be that although his standard of health was as good as anybody else's, his susceptibility to the degenerative diseases part and parcel of the process of ageing was no more than that of the average man and his life expectancy was that of any normal individual, there must be some intrinsic facet of his Service environment which made him look prematurely old in some way readily appreciable to others.

The question which automatically follows is whether, even if this were so, it would be particularly important or noteworthy? I felt that the answer was in the affirmative for the following reasons.

(1) Of itself it would present a most intriguing puzzle in the field of naval health, one whose resolution would be much more amenable to research than among the civilian population in view of the regimented and stereotyped life of the sailor, and whose solution would afford considerable academic satisfaction.

(2) The elucidation of such a problem would demonstrate that environmental influence, though perhaps undetectable in individuals, might be detectable among groups. A naval investigation of this kind might be a useful baseline tool for the examination of other community groups (e.g. convicts, mineworkers, farmers).

(3) If ever this spurious impression of ageing became accessible to public opinion and the Admiralty had no straightforward explanation with which to provide reassurances, there might be considerable resultant resistance to recruitment.

It cannot be doubted that this was one of the factors which made the eradication of widespread tuberculosis in the Navy such a pressing matter in 1944 (Brooks, 1952).

Turning to the second possibility, that ratings were ageing more rapidly as a group than the community as a whole, one first of all asks oneself whether this is in any case conceivable? The answer would seem a firm negative; one would think that a young man is young and an old man is old. The difference between the young man's vitality and the old man's degeneracy should be measurable and predictable according to the years between them. The ageing of tissues with the years would seem as inevitable as time itself, immutable, indifferent to our activities.

Further examination from a broader standpoint weakens the conviction of such assurances, however.

Ageing is a process whose progress is highly species specific (Colloquia on Ageing, 1959) yet the form of degeneracy in each species appears the same.

A very old man, a very old horse and a very old rat examined together would present so many features in common that one might call them equally degenerated by time, yet their ages could easily be respectively 80, 30 and 3 years. This carries the immediate implication that the passage of time is not the sole basis of the phenomenon.

and that the [illegible] and its internal and external [illegible] carry some [illegible]logical responsibility

Metchnikoff (1907) was so impressed by ageing differences between species that he constructed an elaborate theory of senescence (and its prevention!) which was largely based on this evidence

But even within our own species as a whole there is good evidence that life span has varied widely from one era to another and that some races are much shorter lived than others (as in India for example) (Dublin 1952) To imagine therefore that the senescent process (which is not the same thing by any means) might similarly vary within our species would not seem too outrageous In fact, variation in the rate of ageing between individuals is taken as a matter of course in everyday life and a glance at any life table will confirm how wide is the scatter around the life expectancy mean It is a matter of common observation among pathologists how severe degenerative changes can be in middle-aged people and how little degeneration is sometimes in evidence in older men (Kountz 1952) (Arden 1961) We have the condition progeria, in which ageing may apparently overcome its victim before he is out of his childhood as evidence that the orderly pattern of degeneration may be subject to influence (Carlson, 1952)

If there is some species specific regulating mechanism for the rate of ageing and life expectancy and if its influence can vary widely in individuals is it altogether impossible that one group of people differing as a whole in its ways from the community at large might be found to degenerate at a different rate?

It would seem conceivable

In this instance it is unnecessary to ask whether such a state of affairs would be important A discovery of this nature would call for a most urgent investigation into the qualities and peculiarities of naval life not only for the sake of the individuals involved but also for its value as a key to some of the problems of ageing as a whole perhaps to the ultimate benefit of the entire community It would be difficult to justify recruitment into the peace-time Navy if resolution of the aetiology of such a phenomenon were not achieved

Supposing we assumed that the appearance of ageing or even ageing itself might vary between groups of people can naval ratings justifiably be defined as a separate group? Is it possible that their way of life differs sufficiently from that of the community as a whole to merit recognition as a separate entity? If not then investigation for group characteristics (such as premature ageing) would be unjustifiable and pointless

It is certainly evident that naval personnel have been recognizable as a group from a public health standpoint in the past James Lind in his Treatise on Scurvy (1753) showed how a sailor s way of life was responsible for the prevalence of this condition simply because his dietary routine did not include fresh fruit and vegetables

Even towards the end of the last war, the initiation of mass miniature radiography made it evident that the sailor s way of life was still conducive to a higher incidence of tuberculosis than that of the population at large In this instance the crowded conditions of the ships mess decks aggravated by war time exigencies were probably responsible It was not infrequent to encounter localized epidemics of tuberculosis in

ships at sea for long periods for example destroyers concerned with Atlantic convoys during the war (Brooks 1953) In the present context it must be remembered that the senior ratings under examination today were all in the war and subject to all its direct and indirect effects on naval life

Examination of the rating's way of life brings out many differences from that of the civilian, some of which might carry potential importance e g

(1) *General living conditions* The factor of close community living has already been mentioned in relation to a sea going career Contrary to what one would expect the average rating at sea lives and works in an artificially lighted and ventilated environment much more than he does in the open because most of the work involved in running a ship nowadays is carried out below decks On board a modern warship there is a fairly high level of background noise from machinery and ventilation trunking to which the rating is constantly exposed, night and day Similarly, in a ship at sea he is subjected to constant background movement due to roll and pitch

(2) *Diet* One essential difference between the average rating and the civilian is that his food is cooked by mass catering methods throughout his service, in barracks and at sea There is of necessity a high proportion of deep fat fried foods in the rating's diet This fact makes the rehabilitation of cases of peptic ulcer into normal service life a matter of great difficulty

(3) *Alcohol* The issue of one-eighth of a pint of Jamaica rum daily in barracks and on board ship to every naval rating throughout his career quite apart from any liquor that he might buy for himself puts naval ratings into a class of heavier drinkers than the average That the average rating accepts his ' tot ' rather than the alternative 3d per day extra pay will be seen from Table 1 which shows the result of questioning 332 ratings at random on the subject

TABLE 1

Incidence of habitual tot taking as stated by 332 ratings

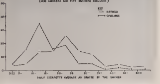
Age	25-	30-	35-	40 45	All ages
Total	105	79	72	76	332
Tot takers	83	62	64	71	280
Per cent	79%	78%	88%	93%	84%

It must be noted that these ratings are not a cross section of the whole community Officers W R N S and juniors are not entitled to rum allowance Also ratings are not entitled to draw the ' tot ' if they are living at home rather than in a naval establishment

For comparison I questioned a group of dockyard civilians of roughly similar social class about their drinking habits Of 82 men none drank spirits daily Only 10

(12 per cent) said that they drank beer daily and 53 (65 per cent) drank beer occasionally or at weekends. 19 (23 per cent) were teetotal. I think it is worth noting that a man who is used to a substantial spirituous drink at midday is far more likely to require this stimulant as an adjunct to his entertainment at other times than one not so accustomed. There is therefore little doubt that the rating drinks much more heavily than his civilian counterpart.

(4) *Tobacco*. Apart from anything else he might smoke, the rating ashore can buy 300 duty free cigarettes (or equivalent tobacco) per month. This costs him about seven shillings. When he is at sea or the Home Station he is allowed 500 or 600 cigarettes. The civilian's financial barrier to heavy smoking is therefore lifted for the sailor exclusively throughout his service. Undoubtedly the rating takes advantage of the situation by smoking relatively heavily. I asked 346 ratings about their smoking habits. Only 42 (12 per cent) were non smokers. Among the 286 cigarette smokers consumption was as in the diagram (Fig. 1).



For comparison I asked 227 random dockyard civilians about smoking. 19 per cent were non-smokers. The cigarette consumption of the others is also represented in Fig. 1, where it can be seen that, whereas the largest percentage of civilians smoke 10 to 15 cigarettes a day, the equivalent figure for ratings is 20 to 25. Admittedly this financial advantage over civilians has only been operative since 1940 for there was hardly any duty on cigarettes before the war. Nevertheless the present generation of senior ratings would have been affected by it. It need hardly be added that tobacco consumption in excess is not a negligible environmental hazard (Doll, 1950) and it is evident that the Navy is more at risk to this hazard than the community at large.

Two separate trials were undertaken the first 14 patients being used for a double blind trial and the remainder for a straight trial

In each trial care was taken to ensure that patients did not know they were receiving a new drug and in all cases no other drug or treatment was given

In recording the response two criteria were used relief from pain and increased ability to undertake their normal work This was of necessity a subjective impression of the patient and only a definite response was taken as indicative of good progress

DOUBLE BLIND TRIAL

The first study was undertaken as a double blind trial i e the choice of Sinaxar or Placebo being left to the dispenser the medical officer being unaware of which the patient was receiving The key to the trial was held by the dispenser to the end of the series

The patients received 2 tablets of Sinaxar or Placebo 4 times a day for a period of 7 days and were seen by the medical officer 1 3 5 and 7 days after commencing treatment

Results

The results were tabulated using the dispenser s key, those of the first day being disregarded as the time lapse was markedly different depending on the time of the first attendance which varied from early morning to late evening

Drug	Total Cases	Improvement		
		After 3 days	After 5 days	After 7 days
Sinaxar	7	6	6	6
Placebo	7	1	3	3

Patients receiving Sinaxar Seven patients received Sinaxar In 6 cases marked improvement occurred within 3 days and was maintained The patients were mobile and almost free from pain within this period and no further treatment was required after 7 days In 1 case no improvement was noted but it is interesting to note that he has had 23 separate sick absences in the past 10 years totalling 387 days

Patients receiving Placebo Seven patients received the Placebo In 6 cases no improvement was recorded after 3 days but 3 cases showed some improvement after 5 days Overall in 5 cases further treatment was needed at the end of the 7th day

No side effects were reported

This trial was not conducted over a large series of patients as it was considered unethical to knowingly withhold all treatment from some patients for a period of 7 days

STRAIGHT TRIAL

The last 20 patients were all given Sinaxar. In view of the results obtained in the double blind trial the same daily dosage of the drug was administered but for a shorter period of 5 days.

Results

Drug	Total Cases	Improvement		
		After 3 days	After 5 days	After 7 days
Sinaxar	20	16	18	18

The results show that in 16 out of 20 cases there was marked response in 3 days and in 18 cases in 5 days. One of the latter cases relapsed within 2 weeks. The 2 cases where no improvement occurred were treated in the physiotherapy department for 2 weeks before showing marked improvement.

Again no side effects were reported.

Summary

Two trials are described of Sinaxar (a muscle relaxant) in a series of industrial employees with muscle sprains of the back attributable to their work.

In the double blind trial 6 (85.7 per cent) of cases showed marked relief of symptoms in 3 days whilst of the control series 6 (85.7 per cent) showed no improvement in that time.

In the straight trial 16 (80 per cent) showed marked improvement in that time.

It is considered that this drug has a place in the treatment of industrial back conditions.

ACKNOWLEDGMENT

I am grateful to Rear Admiral I. W. T. Beloe, D.S.C., Admiral Superintendent and Surgeon Commander W. H. E. McKee, R.N., Senior Medical Officer, H.M. Dockyard, Chatham, for permission to publish this article, to Mr. R. Adam, Senior Surgery Assistant, for acting as dispenser, and to Armour Pharmaceutical Company Limited for supplies of Sinaxar and Placebo.

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(5) *Climate*. The rating in his travels is exposed to a far wider variation in climatic conditions than the average civilian. In particular, a rating cannot complete his service in the Navy without having spent time—perhaps years—in the tropics. In crowded ships he is liable to spend long periods in hot atmospheres and run the risk of salt and water depletion.

(6) *Psychological factors*. The promotion structure of the Navy is such that a rating works in a highly competitive environment until he has reached the rank of chief petty officer. He is then regarded as a very senior man whatever his age. After 15 years service, the Admiralty gives him long-service and good-conduct medals and he is considered an old veteran. Though he may be only 35, he is excused vigorous sports if he wishes. At about 40, he has finished with the Service and is pensioned off. Throughout service, he has lived in a regimented routine and has been often away from his wife and children for long periods (there were no married quarters at home or abroad for ratings until after the war). At every port abroad he must face the lure of dockside vicious entertainment every time he goes ashore, and no one that he cares about at home will know whether he yields to temptation or not. This explains to some extent the higher than average incidence of venereal disease among sailors (B.R. 26(1) 1960). I made a personal random study of the medical documents of 180 senior ratings over the age of 30 years. There was a past history of venereal disease of some kind in 47 of these. This represents an incidence of 26 per cent.

The above examples illustrate that the life of a sailor has qualities which distinguish it from that of the man in the street. Investigation of ratings as a group in respect of an impression of premature ageing would therefore be justifiable.

Summary

There is a current impression that ratings look older than their years.

This could represent some superficial change which does not imply any premature degeneration.

On the other hand it might be that ratings are ageing more rapidly than other people.

A sailor's life has distinctive qualities that make ratings recognizable as a group and therefore amenable to investigation as such.

(To be continued)

TREATMENT OF THE INDUSTRIAL BACK— A CLINICAL TRIAL OF SINAXAR

By Surgeon Lieutenant-Commander T P OLIVER, R N

DESPITE increasing mechanization in industry there are still many occupations where much of the work is manual labour Amongst the conditions which the industrial medical officer is called upon to treat is the so-called "industrial back"

Of the many employees who seek medical advice for back pain Johnstone (1942) estimates that only 30 per cent are suffering from back conditions related to their work These industrial back conditions can be divided into three main groups

(1) Trauma to muscles attached to the vertebral column

(2) Lesions of the joints of the vertebral column and the sacro-iliac joints

(3) Fractures of the vertebra

It is muscle trauma that is being considered in this paper Strain of the long muscles causes acute pain which appears to be due to spasm of these muscles which further results in a decrease in mobility of the patient Analgesics can be used to dull the pain caused by the spasm but to relieve this spasm should be a far more effective therapeutic measure

It is important that any drug used in industrial practice has no side effects (e g sedation or vertigo may result in accidents) It should also be easy to administer and relatively long acting The ideal is an oral tablet taken not more than four times a day

Sinaxar is a skeletal muscle relaxant which is said to fulfil these criteria

Pharmacology

Sinaxar is 2-hydroxy 2 phenylethyl carbamate It acts centrally by interrupting nerve transmission in the spinal cord and brain stem It has no effect on the respiratory centre and does not induce drowsiness It is easily absorbed from the gastro intestinal tract and exerts its action within 15 minutes after oral administration as shown by Chasrow *et al* (1960) Further Davis *et al* (1959) have shown that it has no untoward toxicity

Clinical Studies

Thirty four patients of both sexes whose ages ranged from 18 to 65 were selected for study from attendances at the medical centre in a royal dockyard All complained of acute back pain following lifting or twisting movements of the vertebral column Patients with a past history of "back" conditions with proved prolapsed intervertebral discs or other lesions of the vertebral column and those with chronic central nervous system diseases were excluded French (1962) has described the difficulties in diagnosis in cases of back injury

Clinical Case

A CASE OF FIBRO-OSTEOMA OF MANDIBLE

By Surgeon Captain (D) A MACDONALD WATSON, R N , and

Surgeon Lieutenant-Commander (D) J D SIEVERS R N

This patient was referred by his own dental officer with a fibrous growth on the occlusal surface of the mandible in $\overline{|5}$ region on 31st October 1961 $\overline{|5}$ was missing. The growth was firm non fluctuant and the overlying gingival tissue was fairly normal in colour and appearance The growth had only been noticed for some 4 to 6 weeks by the patient and there was no accompanying discomfort

X ray report " In the left lower $\overline{|5}$ area there is a mainly translucent swelling with bony spicules crossing it It appears to have lifted the cortical bone and left a ragged appearance of the alveolar margin This appearance is confirmed in the occlusal view "

In view of the doubt with regard to the diagnosis the patient was referred to the consultant dental surgeon, whose opinion was that the lesion was probably an ossefying fibroma although the possibility of a lower grade osteogenic sarcoma had to be considered in view of the apparent lifting up of the periosteum which showed in the occlusal X ray film

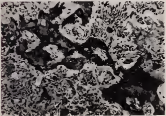
At Operation (Mr N L Rowe Holy Cross Hospital, Haslemere)

On 26th January 1962 an incision was made on the buccal side of the ridge in $\overline{|5}$ region and a flap reflected down the lingual side The tissue exposed was found to be soft and was readily curretted down to hard bone The curretted material was granular to touch and constant with calcification taking place within it The overlying gingival tissue was excised and the wound closed with interrupted black silk sutures

Pathologist's report Parts of the specimen consist of irregular masses of highly calcified cementum like tissue lying in a moderately cellular fibrous stroma In other areas the soft tissue is more cellular and contains islands and bars of dysplastic bone and osteoid Where the lesion approaches the oral mucosa it is demarcated peripherally by a periosteum like layer Although cellular and active I think that this tumour is benign and it may be classified as a fibro osteoma "

After operation he was sent on sick leave and discharged finally on 20th February 1962 The case was reviewed on 16th May 1962 when X-ray report stated " No localized recurrence of the cystic lesion is seen in the $\overline{|5}$ region "

We wish to thank Surgeon Rear-Admiral D D Steele Perkins *C V O* , Q H S F R C S , F R A C S D L O for his kind permission to publish this article



Reviews

THE DIAGNOSIS [illegible] POISONING. By J. D. P[illegible] B.S., M.D., F.R.C.P. (Edin.), F.R.I.C. [illegible] 4 [illegible] plate. London: Oxford [illegible] Press. Price 15s.

The [illegible] is the general practitioner [illegible] without the encyclopaedic [illegible] in the undergraduate [illegible] journals. He has produced [illegible] book full of common sense and with [illegible] his reader a good perspective [illegible] poisoning. His range is great, covering natural items such as plants and [illegible] found in industry, agriculture and medicine. He does not waste space on [illegible] poisonous under special circumstances such as the toxicity of oxygen in [illegible].

His first 100 pages [illegible] dealing with such aspects as incidence, epidemiology, different [illegible] of treatment. Throughout, a major feature of the lay-out is the number of [illegible] reference easy. There is very little repetition in the later sections dealing with [illegible] appendices give much help on the collection of samples, performance [illegible] equipment to have available. A further appendix of 18 pages intended [illegible] of the toxic ingredient in many proprietary preparations actually [illegible] the medical profession for the dangers of their treatments.

The book [illegible] successfully spotted and the considerable long interval between the writing [illegible] comments. Mouth to Mouth artificial respiration is described [illegible] plate, and some script is devoted to the less-efficient Holger Nielsen [illegible] means naval medical officers particularly in that they may be [illegible] to treat carbon monoxide poisoning as described by Illingworth and [illegible] only one line in this edition. However, this book fulfils the [illegible] and is well worth the cost to any doctor. D. E. M.

LUNG FUNCTION [illegible] M.D., M.R.C.P. (Lond.). Second edition. Pp. xi+84. Twenty illustrations [illegible] H. K. Lewis & Co. Ltd. Price 12s. 6d. 4d. Home Postage.

This small book [illegible] added to the heading on the title page and this presumably permits the author [illegible] tests but to spend a large proportion of the reader's time discussing [illegible] respiratory physiology and the possible tests used for each condition. [illegible] may [illegible] possible [illegible] and other words implying vagueness and doubt [illegible] practical techniques of lung function tests—something that is really needed [illegible] the beginner. Those more experienced have no need of a reference of this type. [illegible] the use of the lung function tests, the desire for compactness has led to a very [illegible] which however is redeemed by a list of references at the end of each section so enabling one to find the necessary information. The seven pages of standards and values are useful but not worth the cost of obtaining the booklet.

D. F. M.

PATHOLOGY OF THE NERVOUS SYSTEM. By J. Henry Biggart, C.B.E., M.D., D.Sc., F.R.C.P. Third edition. Pp. xii + 368, 239 illustrations and 22 coloured plates. Edinburgh and London: E. & S. Livingstone Ltd. Price 40s. Home Postage 1s. 9d.

The title of this book implies that it is intended for use by students and it is in fact a most suitable book for their use. I would not be surprised, however, to find it on the shelves of many practising pathologists and histopathologists. The descriptions of the macroscopic and microscopic pathological changes are most lucid and each description is illustrated by one or more microphotographs of quite exceptional excellence. In dealing with this specialised branch of histopathology the author has been to considerable pains to retain within the reader's mind a sense of perspective. On many occasions he draws analogies between the changes occurring in nervous tissue and those occurring in other parts of the body in similar and allied diseases.

This is altogether an excellent book.

P. W. E.

BIOCHEMICAL INVESTIGATIONS IN DIAGNOSIS AND TREATMENT. By John D. N. Nabarro, M.D., F.R.C.P. Third edition. Pp. ix + 298. London: H. K. Lewis & Co. Ltd. Price 30s.

This book lives up to the standard it has already set and presents a very wide field of biochemical investigation in a compact manner which can be understood and appreciated by the average doctor. For the specialist it provides a ready book of reference and a place must be found for it on every laboratory book-shelf.

The early chapters on water balance and hydrogen ion equilibrium are so important as to deserve their place, and as more and more attention is being paid to this particular aspect of biochemistry, especially with regard to heat illness, this account produces a very good starting point for the environmental physiologist.

Potassium, magnesium, iron and copper have a chapter to themselves but it is somewhat disap

po[illegible] small th[illegible] ment [illegible] between [illegible] Conver[illegible] this is [illegible]

The [illegible] text books

It [illegible] rather [illegible] picture [illegible] no more than [illegible] subject [illegible] all [illegible] tables [illegible] values are welcome. The bo[illegible] and well [illegible] S M

MEDICAL PRECEPTS [illegible] By Michael Gelfand C B E M D F R C P D P H D M R. Pp [illegible] E & S Livingstone Ltd. Price 2s

This unique little [illegible] 144 pearls of wisdom for the busy doctor in Tropical Africa. These are arranged [illegible] but are startlingly precise. A few examples may be taken at random [illegible] In the tropics not every fever is malarial. No 29. In Africa the [illegible] than it is in Europe. No 43. Any lesion at the right base of the lung [illegible] No 107. An African with a chronic sore on a finger may be a lepe[illegible]

This [illegible] book [illegible] two shillings can be slipped easily into the pocket of any tropical shirt and pull[illegible] for quick revision. It must be studied quite independently of any problem [illegible] specific reference. S M

MACKIE AND McCARTNEY [illegible] Edited by Robert Cruickshank M D F R C P D P H F R S E [illegible] Pp xi 980. Edinburgh and London E & S Livingstone Ltd. Price 40[illegible]

Within an hour of [illegible] on the bench. There after it had to be read them in the old m[illegible] the standard work in many English speaking (or reading) bacteriological [illegible] is now edited by Professor Robert Cruickshank and compiled with six of his [illegible] Department of Bacteriology University of Edinburgh. Since the last edition [illegible] section has grown by 76 pages. Personal feeling is that it has [illegible] and that any more editions will move this old friend from the [illegible] in the reference library. My Mediterranean colleagues suggest th[illegible] could be omitted in the next edition. P K F

AVIATION ACCIDENT PATHOLOGY. By J K Mason M D (Cantab) D C P (Lond). Pp xvi 358. Many black and white photographs and illustrations. London Butterworth & Co Ltd. Price 90s

At a time when both civilian and military medical services are becoming particularly conscious of the importance of studying the whole sequence of events it is [illegible] that in the very special field of aviation accidents [illegible] should be made available. Doctor Mason is well known and respected for the work he has been doing for many years in organizing a study of events and sequels associated with aircraft accidents. This work represents the fruits of his labour and he is to be congratulated on the [illegible] and informative presentation which he offers. There is an abundance of reliable statistical data carefully tabulated and analysed with a number of excellent though startling photographs which must convince the reader of the importance of making every effort to [illegible] such tragedies. Most important is the section on human factors which undoubtedly accounts for the majority of accidents.

Though a little bit expensive at 90s this book will undoubtedly make a major contribution to accident prevention in general. M S

GENETICS FOR THE CLINICIAN. By C A Clarke M A M D F R C P. Pp xiv 294. Black and white plates and illustrations. Oxford Blackwell Scientific publications. Price 47s 6d

The surprising feature of this book is the modesty of the title. It will be of the utmost interest and value to a much larger range of readers than the clinician and it is hoped that the title will not limit its circulation.

At a time when not only clinicians but biologists health physicists and physiologists are becoming increasingly interested in the problems of genetics particularly in association with ionizing radiation this book comes at a most appropriate time.

Working steadily through the basic principles of genetics in man a full study of heredity problems evolves. The work is one of outstanding merit with abundant and clear illustrations as well as a most welcome list of references at the end of each chapter.

Two of the chapters are particularly good. The biological effects of ionizing radiations which condenses into a readable chapter a very large and complicated subject and in the final pages the most refreshing account of elementary statistics gives the reader whatever his speciality a simple insight into the use and importance of statistical methods. For the stranger to genetics a glossary offers a tidy account of the appropriate terminology. S M

H[illegible] and Gillespie [illegible]. Revised by Sir David Henderson, M.D., D.Sc., LL.D., F.R.C.P., F.R.C.P.E. [illegible] R. C. Batchelor, M.B., Ch.B., F.R.C.P.E., D.P.M., F.R.S.E. Ninth [illegible]. London: Oxford University Press. Price 42s.

[illegible] *Textbook of Psychiatry* by [illegible] was first published in 1927. Now in 196[illegible] [illegible] edition of this work [illegible]. That in itself is a measure of the reputation which [illegible] book has established [illegible].

This latest edition has been [illegible] revised by the authors and in many parts completely [illegible] to bring the text [illegible] theory and practice in psychiatry.

A [illegible] chapter on the [illegible] psychiatry and general medicine has been included. [illegible] in this chapter [illegible] emphasis that psychiatry must be re[illegible] part of general medicine [illegible] which can be followed both in teaching and [illegible] everyday life [illegible] being able to make a valuable contribution [illegible] understanding and [illegible] medical problems of this age.

The chapter on the [illegible] psychiatry and the law has also been completely revised [illegible] of the changes [illegible] followed both the Mental Health Acts [illegible] and 1960, the [illegible] and the Homicide Act 1957.

[illegible] comprehensive account of mental illness in all its [illegible] forms. [illegible] diagnosis and treatment are all discussed in detail and [illegible] illustrated by carefully chosen case histories. In this [illegible] has dispensed with some of those case histories [illegible] the passage of time and changed social and medical [illegible] to be.

In conclusion [illegible] edition of this work fully lives up to the reputation [illegible] with confidence this *Textbook of Psychiatry* [illegible] from medical student to consultant.

W. C.

HUMAN PROBLEMS [illegible]. Edited by A. Buchanan Barbour and Sir Harold [illegible] Proceedings of the Fifth European Congress of Aviation Medicine, London [illegible] 1960. Oxford: Pergamon Press Ltd. Price £1 10s. 0d.

Many conferences [illegible] are held each year in various parts of the world. Invariably they [illegible] of academic knowledge and experience although all too frequently [illegible] lose the significance of their impact in their particular field. It [illegible] that the 1960 London Conference on Aviation Medicine should [illegible] reported as in this particular volume.

The monograph [illegible] helpful articles on flying personnel research. Amongst these the paper [illegible] on the early detection of coronary artery disease is particularly welcome [illegible] around this delicate problem and there are those who would prefer [illegible] this frightening disease whilst others would prefer [illegible] their way of life accordingly. The paper and its summary [illegible] and convincing manner and includes some commonsense advice.

It is most difficult [illegible] in what must be a very inadequate review. The names of the [illegible] writers give the whole publication an air of authority. Furthermore, they lead [illegible] where further research is of paramount importance and emphasise the need to correlate human performance, experience and ability within the more restricted parameters of present day aeronautical equipment. It is comforting to see a complete section devoted to environment and safety.

The final section of miscellaneous papers is a refreshing climax to its comprehensive predecessors and covers a range varying from fatigue in the tropics to medical fitness in identical twins. It is therefore considered desirable, if not essential, that any medical officer in any way associated with aviation medicine should study this outstanding contribution to this new and important science.

M. S.

We acknowledge with thanks receipt of the following publications:

Acta Medica et Biologica. Annales Chirurgie et Gynaecologie Fenniae. Annales Medicinae Internae Fenniae. Annali di Medicina Navale. Annals of Tropical Medicine and Parasitology. Australian Journal of Experimental Biology and Medical Science. Australian and New Zealand Journal of Surgery. British Medical Journal. British Journal of Surgery. B.S.I. News. Bulletin of the World Health Organisation. Guy's Hospital Gazette. Japanese Journal of Medicine. Journal of the Royal Naval Scientific Service. Journal of the Irish Medical Association. Journal of the Royal Army Medical Corps. International Review of the Army, Navy and Air Force Medical Service. Minnesota Medical Journal. Medical Journal of Osaka University. Medical Digest. Medicina Fennica. Military Medicine. Montreal Medical. Nagoya Journal of Medical Science. Nuffield Foundation [illegible] Report. Proceedings of the Staff Meetings of the Mayo Clinic. Revista Medica del Hospital Colonia. Sankyo [illegible]. St. Mary's Hospital Gazette. Tohoku Journal of Experimental Medicine. Vestnik dermatologii i Venerologii. World Health Chronicle.

News of the Service

GOLF

Royal Naval Medical and Dental Officers v. Royal Air Force Medical Golfing Society

The third annual meeting between medical and dental officers of the Royal Navy and Royal Air Force was held at the North Hants Golf Club, Fleet, on Wednesday 13th June. The object of the meeting, to provide an enjoyable day's golf, was achieved and it was satisfactory to be able to record the Navy now lead by the odd match in the series.

It was the general view of those who took part this year that the meeting in 1963 should again be held at Fleet. This is being arranged and golfing readers may care to note the provisional date, Wednesday 12th June.

OBITUARY

Surgeon Rear Admiral F. J. D. TWIGG died on the 3rd July, 1962, in Kenya where he has lived since his retirement in 1946. He was born on the 22nd January, 1888, in Limerick and qualified M.B., B.Ch. in the Royal University of Ireland in July, 1911. He entered the Royal Naval Medical Service in April, 1912 and at the outbreak of the First World War served in H.M.S. *Queen*, the Flagship of Rear Admiral Thursby, taking part in the operations in Gallipoli. During the last two years of the war he was in charge of the Royal Naval Hospital in H.M. Island Ascension.

In 1922 he took up the practice of ophthalmology in the Navy and obtained his D.O.M.S. in that year. Subsequently he was employed as Ophthalmic Specialist in R.N. Hospital Chatham, H.M. Hospital Ship *Maine* and R.N. Hospital Haslar. In 1931 he became Medical Officer in-Charge of the R.N. Hospital Simonstown and while holding this appointment he was promoted to the rank of Surgeon Captain on 1st May 1934. He held a further hospital appointment in Bermuda and on 9th January, 1942 he was promoted to the rank of Surgeon Rear Admiral and appointed as Medical Officer in Charge of the Royal Naval Hospital Plymouth. He was awarded the *C.B.E.* in the New Year's Honours List 1st January 1946 and appointed K.H.S. on 1st April 1946. The King Haakon VII Liberty Medal was awarded to him in 1947 in recognition of his services during the Second World War.

He served at R.N. Auxiliary Hospital Sherborne from August 1945 until his retirement.

Admiral Twigg's contemporaries in the naval medical service will remember his outstanding qualities as an officer and surgeon. He is survived by his wife to whom their sympathy is extended.

HIGHER QUALIFICATIONS

Surgeon Lieutenant Commander D. G. Birch—M.R.C.O.G. July, 1962.
Surgeon Lieutenant Commander J. H. Kemp—D.T.H. July, 1962.
Surgeon Lieutenant Commander D. R. B. Mends—D.T.M. & H. July, 1962.
Surgeon Lieutenant Commander K. P. O'Byrne—D.P.H. July, 1962.
Surgeon Lieutenant Commander R. V. Williams—F.R.F.P.S. June, 1962. M.R.C.P. (Edin.) July, 1962.
Surgeon Lieutenant J. M. Laurent—D.Obst.R.C.O.G. April, 1962 and D.I.H. July, 1962.
Surgeon Lieutenant M. H. Parsons—D.Obst.R.C.O.G. April, 1962.

NEW ENTRIES

Surgeon Lieutenant Commanders J. A. Cameron, M.B., Ch.B. and P. G. Harries, M.B., B.S. Surgeon Lieutenants A. N. McCann, M.B., B.S., J. R. Johnson, M.A., L.M.S.S.A., R. G. Wilson, M.B., Ch.B., M. A. Macleod, M.B., Ch.B., J. A. Thorn, M.B., Ch.B., R. L. H. Cleave, M.A., B.M., B.Ch., J. G. Goundry, M.B., B.S., B. W. Rixon, M.B., Ch.B. Surgeon Lieutenants (D) E. J. Grant, V.D.S., L.D.S., R. G. Bishop, B.D.S., M. J. Ralph, L.D.S., Miss K. Billings, B.D.S., Miss P. L. Cooper, B.D.S., L. J. Madden, L.D.S.

PRE-REGISTRATION ENTRIES

Acting Surgeon Lieutenants A. J. Reed, M.B., B.S. and M. B. Worrall, M.R.C.S., L.R.C.S.

TRANSFERS TO THE PERMANENT SERVICE

Surgeon Lieutenant A. M. Hazell, M.B., B.S., Surgeon Lieutenant P. G. Bond, M.B., B.S. and Surgeon Lieutenant J. W. Davies, M.B., Ch.B.

SHORT SERVICE COMMISSION CONVERTED TO FIVE YEARS

Surgeon Lieutenants P. Dean, M.B., Ch.B., A. S. Jarrett, M.S., M.B., B.S., G. A. Langdale, B.M., B.Ch., J. M. Laurent, M.B., B.S., M.R.C.S., L.R.C.P., D.Obst.R.C.O.G., D.I.H., J. Lavender, M.B., B.S., M.R.C.S., L.R.C.P., D.Obst.R.C.O.G., M. H. Parsons, B.M., B.Ch., D.Obst.R.C.O.G., A. J. Pochin, M.B., B.S., M.R.C.S., L.R.C.P., J. B. Reynolds, M.R.C.S., L.R.C.P., J. F. Rivers, M.B., B.S., D. B. Watkin, M.R., Ch.B., A. G. Watson, M.B., Ch.B.

PROMOTIONS

To Surgeon Captain R W Duncan M B B Ch B Ridgway M B Ch B D M R D B M Goldsworthy M B B S M R C S L R C P D M R D F H Lamb M R C S L R C P
To Surgeon Captain (D) D C Howe L D S
To Surgeon Commander C W Ussher M R C S L R C P W E Willder L R C P & S L R F P S F J O Kelly M B, B Ch D P H J A B Harrison M R C S L R C P D M R D
Surgeon Commander (D) P R Rogers L D S
To Surgeon Lieutenant Commander K T Hesketh M B B S L R C P F R C S (Edin) J Bertram M B B S M G Williams M B B Ch M R C S L R C P M P Brady M B Ch B D H Elliott M B B S D Obst R C O G
To Surgeon Lieutenant Commander (D) D M Lindsay B D S

Provisional selections for promotion to date 31st December, 1962

To Surgeon Captain K J O'Connor M R C S L R C P F S Edgecombe B A M R C S L R C P D I H and J A McLaren M B Ch B D T M & H
To Surgeon Captain (D) E B Markinson L D S
To Surgeon Commander I H Colley M B B S M R C S L R C P D P H R H Etherington M B B S W A N Mackie *D S C* M B Ch B C O L Hughes M B Ch B D C P P W Head M B B S D L O J M Haughton M R C S L R C P F F A R C S
Surgeon Commander (D) P R J Daly L D S and R L Travis B D S
N B—In future Provisional Selections will not be repeated on confirmation of promotion

RETIREMENTS

Surgeon Commander M G Ross M B Ch B M R C S L R C P (Age) 7 8 62
Surgeon Commander W H E McKee M B B Ch D P H (Own Request) 31 7 62
Surgeon Commander (D) W E A Watson L D S (Age) 17 8 62

RELEASED ON COMPLETION OF SHORT SERVICE COMMISSION

Surgeon Lieutenant Commanders D A E Shepherd and R W K Rogers
Surgeon Lieutenants M J Brindle S J S Rippon G H Helnods F H Pattisson G Wray G W Jones A W Jones B H Delaney D E Longson and Surgeon Lieutenant (D) B Hendon ✓

QUEEN ALEXANDRA'S ROYAL NAVAL NURSING SERVICE

Promoted to Superintending Sister Matron Miss M E Lewis A R R C 1 10 62
Promoted to Superintending Sisters Misses P M Penn and P J D Reilly
Retirement Miss G M Griffiths A R R C Superintending Sister (Age) 25 9 62

ROYAL NAVAL RESERVE
ENTERED INTO PERMANENT R N R

To Acting Surgeon Sub-Lieutenants C D Fisher D G W Fosbery A M Roberts K W J Taylor and C W Howell

PROMOTIONS

To Surgeon Lieutenant Commander J H Capon M R C S L R C P D A F F A R C S and J B Armstrong M B Ch B H M Ross M B F R C S D B L Skeggs M A B M B Ch
To Surgeon Lieutenant Commander (D) M C Rosen L D S R C S A N DuPlessis L D S R C S M N Naylor B Sc L D S

RETIREMENTS

Surgeon Commander F R Badenoch *M B E* V R D M B Ch B (Age) 27 6 62
Surgeon Lieutenant Commander M W F Dunning F R C S L R C P L D S, V R D (Age) 6 8 62
Surgeon Lieutenant-Commander J Lamine V R D M B Ch B D C H (Resignation accepted on entry into H K R N V R) 1 6 62
Surgeon Lieutenant-Commander I D M Nelson M B B Ch D P H (Age) 26 8 62
Surgeon Lieutenant E B Germar M B B S (Commission terminated) 26 6 62

CIVILIAN APPOINTMENTS TO NAVAL ESTABLISHMENTS

Surgeon Captain J G Holmes *O B E* R N (Retired) R N Atomic Defence School H M S *Excellent* 5 3 62
Surgeon Captain J G Maguire, *C B E* R N (Retired) H M S *Ariel* (for duty at R.N.A.Y Fleetlands) 2 4 62
Surgeon Captain J H Nicholson R N (Retired) H M Dockyard Rosyth 19 3 62
Brigadier J B Black R A M C (Retired) R N A S Lossiemouth 1 6 62
Surgeon Commander R L Lander R N (Retired) H M S *Collingwood* 30 4 62
Surgeon Captain C J P Pearson R N (Retired) B R N C Dartmouth 14 9 62

BIRTH ANNOUNCEMENT

TWIDLE Born to Robert and Ruth Twidle a daughter Naomi at Gull Lake, Saskatchewan, Canada on 8th August 1962

ADMIRALTY FLEET ORDERS

(This page is perforated for filing purposes)

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Notice

The Editor invites medical officers to send in original papers on professional subjects travel personal experiences etc Items of news and matters of interest to the naval medical service will be welcomed from ships and establishments on home and foreign station Notices of births marriages and deaths are inserted free of charge to subscribers

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The Harvard system should be employed for bibliographical references these references being arranged in alphabetical order of the authors names at the end of the contribution, thus SMITH F G (1935) *J roy nav med Serv* **22**, 53 In the text a reference to a publication should be cited by giving the author and in brackets the date thus "Smith (1935) believed this to be due etc , or lack of basic information on the strategic fundamentals of the science of the sea. (Carson, 1956)

The JOURNAL is published quarterly four numbers comprising one volume

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For R N and R N R medical personnel on the active or retired list and for Consultants to the Royal Navy the subscription is 20s per annum (postage included) payable on 1st January of each year Single copies 5s

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Journal

of the

Royal Naval Medical Service

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VOL. XLVIII

1962

EDITED BY
THE STAFF OF THE ROYAL NAVAL MEDICAL SCHOOL
ALVERSTOKE, HAMPSHIRE